

A Literature Review of Panfish Regulations in North America

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Preface

In 2002, the Ministry of Natural Resources embarked on a provincial exercise to review and streamline Ontario's fisheries regulations. This exercise had several components including a rationalization of fishing divisions, the development of regulatory "tool kits" for individual fish species, and an administrative clean-up of existing regulations. The development of tool kits for individual species was intended to ensure that regulations developed on a broad (i.e., landscape) level were based on the best science and information available and would ensure sustainability of the resource. These tool kits would then provide a standard approach (e.g., list of potential regulatory options) for the development of any new regulations in the future.

This literature review was conducted to assemble and consolidate background reference material for the development of the panfish tool kit. Species of fish included under the panfish category are bluegill (*Lepomis macrochirus*), pumpkinseed (*L. gibbosus*), rock bass (*Ambloplites rupestris*), green sunfish (*L. cyanellus*), orange spotted sunfish (*L. humilis*), redear sunfish (*L. microlophus*) and longear sunfish (*L. megalotis*). Information has been assembled under ten general categories. Complete abstracts have been provided wherever possible. Where abstracts were not available (e.g., grey literature), an attempt has been made to summarize the key points of the study. In some instances, references are included in more than one section, and in some cases we were unable to obtain a copy of the document but have included the citation for future reference.

Finally, a synopsis of panfish regulations in other North American jurisdictions has also been included for comparative purposes. Information for individual jurisdictions was obtained from their 2002 fishing regulation summary.

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Panfish Fisheries and Impacts of Angling

Beard, T. D., Jr. and T. E. Essington. 2000. Effects of angling and life history processes on bluegill size structure: Insights from an individual-based model. Transactions of the American Fisheries Society 129 : 561-568.

Bluegill (*Lepomis macrochirus*) is a common sport fish for anglers, yet populations often suffer from stunting. We examined the effects of life history shifts and fishing mortality on bluegill size structure and on the rate of recovery from exploitation. We constructed an individual-based model that simulated size-dependent age at maturation, differential growth of mature fish, and harvest of individuals larger than 150 mm. We used this model to separate the direct effects of harvest, the direct effects of life history process, and their interactive effects on bluegill size structure. We also evaluated the rate at which bluegill size structure recovered to pre-exploitation levels after eliminating harvest. The direct effect of harvest had the largest effect on bluegill size structure, reducing the mean size of harvestable fish by as much as four times (as compared to results associated with simulations with only life history effects).

Beard, T. D. and J. M. Kampa. 1999. Changes in bluegill, black crappie, and yellow perch populations in Wisconsin during 1967-1991. North American Journal of Fisheries Management 19 : 1037-1043.

A common perception among fisheries managers is that the mean size and number of fish within populations has decreased over time. We examined changes in size of bluegills (*Lepomis macrochirus*), black crappies (*Pomoxis nigromaculatus*) and yellow perch (*Perca flavescens*) in fyke net samples during 1967-1991 to determine changes in size of fish, and in creel surveys during 1980-1991 to determine changes in size of fish harvested and total angler catch and harvest. Mean size and proportion of large bluegills and yellow perch in fyke net samples decreased throughout the sample period. Total catch and harvest of bluegills, black crappies, and yellow perch decreased significantly during 1980-1991. Although mean size of bluegills and yellow perch harvested did not change during 1980-1991, the proportion of large bluegills harvested decreased and the proportion of large black crappies harvested increased. We conclude there was a small, but significant reduction in the size of bluegills and yellow perch in the population and a reduction in the mean size of angler harvested bluegills. Results from this study indicate that there appears to be a major shift in size structure in bluegill and yellow perch population, resulting in smaller, less desirable fish for anglers.

Beyerle, G. B. 1977. Results of attempts to optimize growth and survival of bluegills in ponds by yearly population manipulation. Fisheries Research Report 1856. Michigan Department of Natural Resources. Ann Arbor, Michigan.

Beyerle, G. B. and J. E. Williams. 1972. Survival, growth, and production by bluegills subjected to population reduction in ponds. Fisheries Research Report 1788. Michigan Department of Natural Resources. Ann Arbor, Michigan.

Burdick, B. D. 1979. Biology, reproductive potential, and impact of fishing pressure on the bluegill fishery of Pelican Lake, Uintah County, Utah. M.S. Thesis, Utah State University. Logan, Utah. 235 p.

Coble, D. W. 1988. Effects of angling on bluegill populations: Management implications. North American Journal of Fisheries Management 8 : 277-283.

Angling would affect a fish population if it increased the total mortality rate, reduced numbers or biomass, or reduced the average size of fish in a population by removing the larger ones. Data from the literature indicate that angling commonly affects populations of bluegills (*Lepomis macrochirus*). Substantial exploitation rates (mean, 27%) are not unusual; exploitation is directly related to fishing effort, and angling reduces average size and increases total mortality. Many exploited bluegill populations comprise mainly small fish, less than 150 mm long. Consistent high recruitment of young of the year, size-selective exploitation, and reduced growth and increased natural mortality from competition would tend to produce and maintain such a population size structure. Because angling affects populations, management steps to reduce angling mortality of larger fish, as well as to reduce density of small fish, seem desirable.

Drake, M. T., J. E. Claussen, D. P. Phillip and D. L. Pereira. 1997. A comparison of bluegill reproductive strategies and growth among lakes with different fishing intensities. North American Journal of Fisheries Management 17 : 496-507.

Life history theory suggests that maturation schedules of male bluegill (*Lepomis macrochirus*) and the occurrence of alternative male reproductive strategies (i.e., parental or cuckolder) may contribute to the development and duration of undesirable bluegill population size structure (few fish larger than 150 mm). To investigate this relationship, we assessed parental male maturation schedules and relative abundance of cuckolders in six lakes subject to differing levels of fishing effort. Bluegills were collected by electrofishing shortly after the onset of the spawning season. Lakes with lower fishing effort had parental males that were older and larger at maturity than parental males in lakes with high fishing effort. Also, growth of parental males in lakes with low fishing effort was faster at older ages, and growth of immature males was faster than growth of cuckolders. Unlike other lakes, two of the three low-fishing-effort lakes had very few cuckolders. Our results indicate that intense fishing effort is associated with younger ages and smaller sizes at maturity for parental male bluegills. Also, increased proportions of cuckolders may be associated with increased fishing effort.

Gablehouse, D. W., Jr. 1987. Responses of largemouth bass and bluegills to removal of surplus largemouth bass from a Kansas pond. North American Journal of Fisheries Management 7 : 81-90.

A slot length limit of 30-38 cm was imposed on largemouth bass (*Micropterus salmoides*) in a Kansas pond to improve the species population structure. In conjunction with this limit, 62-91 largemouth bass 20-30 cm long were removed annually per hectare from 1979 to 1983 via electrofishing to stimulate what was considered an appropriate harvest. Both the electrofishing catch rate and estimated number of 20-30 cm long largemouth bass in 1982 were less than half that of 1979. Largemouth bass 30-38 cm long were estimated to be twice as abundant in 1983 as they were in 1979, and over three times as many fish of this size were captured per hour of electrofishing in 1983 as were collected in 1979. Biomass of largemouth bass 20-30 cm long decreased by nearly one-half and the weight of 30-38 cm largemouth bass more than doubled from 1979 to 1983. Only modest improvements in growth rates occurred and condition factors remained less than satisfactory, probably because the removal amounted to less than one-fourth of the estimated number and less than one-third of the estimated biomass of small largemouth



bass present in the first two years of the study; density of surviving bass 20-30 cm long was 229 or more per hectare. As a result, largemouth bass 38 cm and longer were not found until 1983, and then only 3% of all largemouth bass 20 cm and longer were of this size. Bluegill (*Lepomis macrochirus*) recruitment increased, probably due in part to decreased largemouth bass predation. In addition, electrofishing catch rates for bluegills 20 cm and longer increased annually and were over four times higher in 1983 than in 1979. This increase was due to lower mortality rates among age III and older bluegills. Increased longevity of bluegills and their continued good growth and condition, despite increased density, indicated that the removal of largemouth bass may have reduced competition for food between largemouth bass less than 30 cm long and bluegills 15 cm and longer. It may be difficult sometimes to remove sufficient numbers of small largemouth bass to produce a balanced population of this species in situations of high recruitment, but fisheries managers should strive to maintain a proportional stock density of 20-40 and a relative weight of 85-95 for largemouth bass if their interest is in maximizing the production of large bluegills.

Goedde, L. E. and D. W. Coble. 1981. Effects of angling on a previously fished and an unfished warmwater fish community in two Wisconsin lakes. Transactions of the American Fisheries Society 110 : 594-603.

Population structure and other vital statistics were determined for warmwater fish populations in two adjacent lakes for two successive 3-year periods. Allen Lake (7.8 hectares), containing bluegill (*Lepomis macrochirus*), pumpkinseeds (*Lepomis gibbosus*), yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*), and northern pike (*Esox lucius*), was open to angling during, and for about 10 years before this investigation. Mid Lake (4.7 hectares), with the same species, was closed to angling until fishing was permitted throughout the second 3-year period. Before angling began in Mid Lake, large proportions of the populations were of large, old fish, and total annual mortality rates (which were natural mortality rates) were low. The fish populations in Allen Lake comprised mainly small or intermediate size fish throughout the study. After angling in Mid Lake the fish populations and their vital statistics became like those in Allen Lake: length- and age-frequency distributions shifted toward smaller sizes and younger ages, mean age and life spans decreased, mortality rates increased, and proportional stock density declined from values above to values below recommended ranges. The changes in population structure were most pronounced for yellow perch, followed in order by pumpkinseeds, bluegills, largemouth bass, and northern pike. Estimated fishing effort was 231 hours/hectare in May 1976, the first month that Mid Lake was opened to angling, and declined to 62 hours/hectare in May 1979; harvest and catch rate also declined. Estimated exploitation rates (%) in May 1976 for fish of sizes acceptable to anglers were 86 for yellow perch, 74 for pumpkinseed, 35 for bluegill, 53 for largemouth bass, and 46 for northern pike; most fish were taken in the first 2 days. Growth rates in Mid Lake did not change within the period of this study, but bluegills and pumpkinseeds in Allen Lake were growing more slowly than those in Mid Lake before the advent of angling.

Grice, F. 1957. Effect of removal of panfish and trash fish by fyke nets upon fish populations of some Massachusetts' ponds. Transactions of the American Fisheries Society 87 : 108-115.

During the period 1951-56, 127,430 pounds of panfish and trash fish have been removed with fyke nets from 45 ponds in Massachusetts in an attempt to improve gamefish populations. Removal has ranged from less than one to 146 pounds per acre



annually. Data from four ponds ranging in size from 20 to 269 acres are presented in detail. Where removal was intensive, growth rates of panfish increased markedly. Growth rates of gamefish, especially chain pickerel and largemouth black bass, which were returned to the water, showed a slight decrease or no change. Older panfish, remaining after thinning operations, showed less increase in growth rate than did younger fish spawned during or after the operations. No major changes in species composition in favor of gamefish were apparent. It is concluded that the fyke netting has increased growth rates of the species being thinned but has not materially improved gamefish populations.

Jennings, M. J. and T. D. Beard. 1994. Are we putting the pinch on panfish? Wisconsin Natural Resources August 1994 : 17-21.

Bluegill are not exactly an endangered species. Indeed, bluegills and other panfish are so plentiful that it seems impossible to over-harvest them. Consequently, they are liberally managed. In Wisconsin, panfishing is open year-round, the bag limit for each species is 50 fish a day, and there are no size limits. Lately, however, fish managers are listening as more anglers complain of stunted panfish populations, fished-out lakes and overbagging by panfish "hogs".

Jennings, M. J., J. E. Claussen and D. P. Phillip. 1997. Effects of population size structure on reproductive investment of male bluegill. North American Journal of Fisheries Management 17 : 516-524.

Although a goal of fisheries management is to understand factors affecting the growth rate and size structure of exploited populations, the relation between growth rates and variation in reproductive behaviors in *Lepomis* species has received little attention. Allocation of energy to reproductive functions (e.g., gonadal maturation, gamete production, nesting and spawning activities, and brood defense) negatively affects growth rate and, ultimately, maximum body size. To assess how social factors influence energy allocation, we manipulated population size structure of male bluegills (*L. macrochirus*) in experimental ponds and evaluated individual reproductive behavior and testes development. We predicted that smaller parental males would invest less in reproduction in the presence of larger parental males than they would in their absence. Observations were consistent with this prediction; smaller parental males had smaller testes and nested less frequently in the presence of larger males than in their absence. Furthermore, when males of both size-groups occupied nests, larger males were more successful. Size-selective angling that removes larger males may, therefore, negatively affect the size structure of *Lepomis* populations by creating conditions under which smaller, and often younger fish, mature sexually and reproduce. Under those conditions, growth rates would slow at younger ages, and the maximum size attained by these fish would be reduced.

Lux, F. E. and L.L. Smith, Jr. 1960. Some factors influencing seasonal changes in angler catch in a Minnesota lake. Transactions of the American Fisheries Society 89 : 67-79.

An investigation was undertaken in a small Minnesota lake (Linwood) to determine the relationship between angler success for northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*) and crappie (*Pomoxis nigromaculatus*), as well as food availability and food selectivity by these species. Current regulations in Linwood Lake permit year-round angling for sunfish and crappies, winter angling for walleyes and northern pike,

winter spearing of northern pike and summer angling for pike and other species. Average catch-per-hour of pike and panfish combined was highest in June and July of each season. Our data show that a reciprocal relationship existed between total food supply and angler catch during the summer season. In the middle of June, when available food had fallen to its lowest level, angler success approached the seasonal peak. In mid July, as the available food supply climbed, the catch of fish was reduced. Catch rate of pike was highest when the proportion of stomachs containing food was lowest.

Olson, D. E. and P. K. Cunningham. 1989. Sport-fisheries trends shown by an annual Minnesota fishing contest over a 58-year period. North American Journal of Fisheries Management 9 : 287-297.

Since 1915, Fuller's Tackle Shop at Park Rapids in Minnesota's northwestern lake region has sponsored an annual fishing contest. Contest records were available for 113,845 entries of 10 fish species from 1930 to 1987. Under increased exploitation, declining trends in number of large-size entries and mean weight of total entries indicated the development of less desirable size structure for most sport-fish species. The number of entries of muskellunge (*Esox masquinongy*) abruptly declined after the 1930s. Stocking and size restrictions have not restored a trophy muskellunge fishery. Under increased exploitation, entries of large northern pike (*Esox lucius*) have declined gradually since 1948. Numbers of large walleyes (*Stizostedion vitreum*) and largemouth bass (*Micropterus salmoides*) peaked in 1972 and 1977, respectively, and have since declined. Mean weights of bluegills (*Lepomis macrochirus*) and black crappies (*Pomoxis nigromaculatus*) have declined since the early 1950s. Large black crappies (1.75 lb) and bluegills (1.25 lb) nearly disappeared in the 1980s. Increased entries of rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) reflect successful management efforts for these species.

Otis, K. J., R. R. Piette and J. E. Keppler. 1998. A largemouth bass closed fishery to control an overabundant bluegill population in a Wisconsin lake. Journal of Freshwater Ecology 13(4) : 391-403.

We studied Round Lake, in central Wisconsin, to determine if predator-prey balance could be restored by protecting predator populations. In January 1986, the 28.8 hectare lake was closed to fishing for gamefish: largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), and walleye (*Stizostedion vitreum*). Panfish seasons remained open. Largemouth bass and bluegill (*Lepomis macrochirus*) were the predominant predator and prey in Round Lake, with bluegill comprising 58% by weight of the largemouth bass diet from 1984 to 1991. Numbers and biomass of stock length (200+ mm) largemouth bass increased following closure of the lake to predator fishing, and there was a reduction in the population of stock-to-quality (80-149 mm) bluegill. Bluegill biomass remained relatively stable from 1984 to 1992, while bluegill numbers decreased. Bluegill relative weight (Wr) and longevity increased. Increased number of quality (150+ mm) bluegill by 1988 resulted in higher fishing pressure and panfish harvest.

Parsons, B. G. and J. R. Reed. 1998. Angler exploitation of bluegill and black crappie in four West-Central Minnesota Lakes. Fisheries Investigational Report 468. Minnesota Department of Natural Resources. St. Paul, Minnesota. 35 p.

We examined angler rates of exploitation of bluegill (*Lepomis macrochirus*) and black crappie (*Pomoxis nigromaculatus*) in lakes Andrew, Le Homme Dieu, Maple, and Victoria in Douglas County, Minnesota. Bluegill ≥ 150 mm and black crappie ≥ 180 mm caught with trap nets in September and October 1993-1995 were tagged with individually numbered t-bar anchor tags. Exploitation was estimated through voluntary tag returns, and total mortality was estimated by the rate of decline in reporting of fish tagged in 1993. Tag returns were encouraged through a public information campaign and a modest reward program. Reporting rate was estimated to be 69%. Rates of exploitation of bluegill varied among lakes and years and ranged from 8% on Lake Le Homme Dieu in 1994 to 32% on Maple Lake in 1996. Rates of exploitation of black crappie were consistent across years in Lake Le Homme Dieu (26%) and Maple Lake (28%), increased from 9% in 1994 to 34% in 1996 on Lake Andrew, and declined from 33% in 1994 to 7% in 1996 on Lake Victoria. Average total annual mortality in the four lakes was 75% for bluegill and 59% for black crappie. Exploitation appeared to negatively affect the size structure of bluegill and black crappie in these lakes.

Schneider, J. C. 1997. Dynamics of a bluegill, walleye, and yellow perch community. Fisheries Research Report 2020. Michigan Department of Natural Resources. Ann Arbor, Michigan. 72 p.

The addition of bluegill (*Lepomis macrochirus*) to an experimental community of walleye (*Stizostedion vitreum*) and yellow perch (*Perca flavescens*) in Jewett Lake provided an opportunity to evaluate species interactions and fisheries potential. Abundance, size and age structure, growth, mortality, and recruitment of each species were monitored in 1987-95 and compared to walleye and yellow perch data collected in 1975-83. Angler harvest was monitored by voluntary catch survey. Diet studies provided information on predation and potential competition. With the addition of bluegill to the community, total fish biomass doubled to 71 kg/hectare, of which 52% was bluegill. Walleye biomass increased by 11% and yellow perch biomass decreased by 20%. The abundance of large fish changed dramatically: +54% for walleye >356 mm and -76% for yellow perch >178 mm. The biomass gain by walleye was attributed to the utilization of bluegill as food. The biomass loss by yellow perch, mainly by sizes >126 mm, was attributed to competition with bluegill for large zooplankton and benthos. Competition was evidenced by declines in population biomass and individual growth, and diet overlap and shift. Recruitment of YOY perch was unaffected by bluegill, but recruitment of walleye began to fail when bluegill biomass exceeded 50 kg/hectare. Bluegill effects on walleye most likely took place while walleye were in the egg stage (predation) and fry stage (predation and competition for zooplankton); those stages were not sampled. Temperature fluctuations during walleye egg incubation may have also played a role in walleye recruitment failure. Changes in the species populations caused a 7% gain in walleye harvest and a 71% loss in yellow perch harvest. Walleye, as predators, maintained the stability of both communities and the good growth of both bluegill and yellow perch. It is feasible to manage small lakes with either combination of species and to use walleye as a tool to improve growth and size structure of stunted populations of bluegill or yellow perch.



Swingle, H. S. and E. V. Smith. 1941. The management of ponds with stunted fish populations. Transactions of the American Fisheries Society 71 : 102-105.

The principal causes of stunted populations in impounded waters in the Southeast are: overstocking, absence of sufficient carnivorous fish, and heavy weed growth in ponds. Recommended management practices for the correction of these conditions are: (1) weed control, (2) stocking with largemouth black bass, (3) fertilization to increase the food supply, and (4) heavy fishing to reduce the number of fish.

These measures were applied experimentally to a 3-acre pond containing a stunted population of bluegills which had been unable to produce legal-sized fish over a 10-year period. Within 6 months the pond was producing good fishing, and after 18 months, seining sample indicated that 1-year-old bluegills weighed as much as 5 year-old bluegills had at the beginning of the experiment.

Tomcko, C. M. and R. B. Pierce. 1994. The relation of male bluegill reproductive strategies to exploitation and population size structure in twelve Minnesota lakes. Investigational Report 432. Minnesota Department of Natural Resources. St. Paul, Minnesota. 9 p.

No conclusive relationship between the proportion of parental male bluegill and rate of exploitation was established in this study. High proportions of cuckolder males were sampled from two lakes with high fishing pressure (> 200 angler-hours/hectare). In contrast, relatively low proportion of cuckolders were sampled in the lake with the highest fishing pressure. Low proportions of cuckolder males were also sampled from lakes with < 200 angler-hours/hectare fishing pressure. A valuable result of this study was the development of techniques for studying male bluegill reproductive strategies and insights into the difficulties of doing a study of this type.

Wisconsin Department of Natural Resources. 1992. Managing panfish in Wisconsin: A recommendation to the Natural Resources Board. Report from the Panfish Committee. Madison, Wisconsin. 48 p.

Fyke net collections from 1967 to 1991 were used to evaluate the status of natural populations and identify trends in size and growth. The panfish data set included length frequency data as well as age and growth on populations from seven to thirty-seven lakes in each year. Creel survey data from 1980 to 1991 were examined to characterize the angler harvest of panfish and to examine trends in the angler catch and harvest.

General Regulations

Beard, T. D., Jr., M. T. Drake, J. E. Breck and N. A. Nate. 1997. Effects of simulated angling regulations on stunting in bluegill populations. North American Journal of Fisheries Management 17 : 525-532.

Stunting in populations of bluegill (*Lepomis macrochirus*) is a major management problem in the upper midwestern United States. Traditionally, stunting has been attributed to a lack of food resources. An alternative theory suggests that stunting may result from harvest of the large parental males that inhibit spawning by smaller males, allowing males to direct energy to reproduction instead of to growth. We used a



population model to simulate restrictions on harvest of large males under various conditions of vulnerability to angling, growth rate, and angler effort. Regulations tested were a daily bag limit of 5 fish and seasonal bags of 50 fish or 50 fish but only 1 trophy specimen (>180 mm total length); a limit of only 1 trophy fish during spawning season; and a spawning season closure. Growth and angler effort had the greatest effects on size structure in simulated bluegill populations; high growth and low effort led to notable increases in mean fish length. Tested regulations and male vulnerability to angling had little effect on size structure although spawning season closure produced a modest increase in mean length. The simulations also suggested that increases in that proportion of large fish in bluegill populations require regulations that reduce total angler effort. Furthermore, to be successful, effort regulations must be applied to populations that have the potential for good growth.

Christensen, K. E. 1953. Fishing in twelve Michigan lakes under experimental regulations. Fisheries Research Miscellaneous Publication 7. Michigan Department of Conservation. Ann Arbor, Michigan. 46 p.

Christie, W. J. 1978. A study of freshwater fishery regulation based on North American experience. p. 1-46 In FAO Fisheries Technical Paper No. 180. Food and Agriculture Organization of the United Nations. Rome, Italy.

The inland fisheries of Canada are representative of many stages of development varying with the demographic, social and economic conditions of different regions of the country. The scientific management of these fisheries had received considerable attention. Thus, an examination of management practice in Canada, both historically and in relation to these different regional characteristics, provides an opportunity to evaluate management strategy and tactics in order to improve future management wherever substantial inland fishery resources exist. Historically, management of these fisheries has been misdirected and, while effective in accomplishing the goals sought, it has been inappropriate in a larger context. Thus an analysis of the problems of inland fishery management goes beyond scientific aspects. Social and economic factors as well as the status of the resource must be better appreciated if effective management is to be achieved. As the socio-economic requirements vary regionally, a zonal approach to regulations and management is recommended in spite of some inconsistencies which result.

Churchill, W. 1957. Conclusions from a ten year creel census on a lake with no angling restrictions. Journal of Wildlife Management 21(2) : 182-188.

In Wisconsin, Escanaba Lake has been under experimental management since 1946 with no restrictions on hook and line fishing for any species. Escanaba Lake supports a diverse sport fish population including rock bass (*Ambloplites rupestris*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*L. gibbosus*). There is currently no size or season limit on panfish in Wisconsin and the bag limit is 25 of each species. Relatively few catches from Escanaba Lake have exceeded this number.

A complete record of the harvest was kept and other information was collected by means of a compulsory permit system. In ten years, 97,387 fish weighing 49,414 pounds have been harvested. Perch and walleye together made up about 80% of the catch but the proportions of the two species in the catch have varied greatly from year to year. Fishing success has varied from 0.17 to 1.1 fish-per-hour. Fishing regulations in effect elsewhere in Wisconsin would have reduced the 10 year catch of game fish by



more than 50%. Minimum size limits would have had more effect than bag and season limits. There is no evidence of depletion after ten years of unrestricted fishing.

Everhart, W. H., A. W. Eipper and W. D. Youngs. 1975. Regulations and their effects. p. 271-277 In Principles of Fishery Science. Cornell University Press. Ithaca, New York. 288p.

Fisheries have been regulated on the basis of politics, social pressure, gear competition, prejudice, whim, and sometimes for biological reasons. Fisheries regulations are usually aimed at control of the fishermen with little concern given to the biological health of the fish. Most regulations are based on the theory that the fewer fish caught now, the more will be available for future fishing. Another theory is that fish should be protected during the spawning season. Protecting a stock of mature fish may be justified when numbers are extremely low or where the fish are particularly vulnerable to capture during the spawning period. But if fish are not, in fact, more vulnerable to capture during the spawning period, little is gained by extra protection during that season that could not just as well be gained by reducing the catch during the remainder of the year.

Exploitation of a species can be modified by reducing the total quantity or by taking the catch from selected portions of the population. Regulations designed to protect selected portions of the population may or may not result in overall reduction in catch, however. Protection of small fish should always be supported by evidence demonstrating its advantage and the sizes that need protection. Certain areas are often closed to fishing to achieve one or more of the following results: to limit the total catch, to protect fish on spawning grounds, to protect fish while migrating through areas of restricted access, where they are vulnerable to capture, to protect young fish on nursery grounds or to prevent fishing during periods when the smaller fish are more vulnerable to the gear.

Fishing regulations need to be as simple and as few as possible. Fishing regulations should consider total effects and should not be based solely on single species management. When protection is provided for one species more fishing effort may be expended on others. A similar situation exists in freshwater sport fisheries where highly restrictive regulations may actually increase fishing pressure on a few waters instead of spreading it out over many.

Johnson, B. M. and P. J. Martinez. 1995. Selecting harvest regulations for recreational fisheries: Opportunities for research/management cooperation. Fisheries – Special Issue on Problem-Solving Research for Management 20(10) : 22-29.

The need for harvest regulations to manage sport fisheries is widely recognized, but regulations are not always selected and applied scientifically with an assessment of the ecological implications of manipulating harvest. Regulations directed at protecting top predator fishes may have undesirable consequences for other fishes in the system. A strategy is developed for selecting harvest regulations that considers both direct effects of regulations on the target population and indirect effects on other trophic levels. The result is a set of regulatory options that achieve angler and management goals while reducing unexpected or adverse responses within the fish community. This approach requires fishery researchers and managers to work closely together to be effective, and, thus, the regulation selection process offers excellent opportunity for research and management.

Langlois, T. H. 1944. The role of legal restrictions in fish management. p. 197-202 *In* Transactions of the Ninth North American Wildlife Conference. Chicago, Illinois.

Noble, R. L. and T. W. Jones. 1993. Managing fisheries with regulations. p. 383-402 *In* C. C. Kohler and W. A. Hubert [eds]. Inland Fisheries Management in North America. American Fisheries Society. Bethesda, Maryland.

Successful fisheries management must incorporate the use of appropriate and effective regulations along with other management tools to meet defined management objectives. Regulations are tools to be used in conjunction with other management practices such as population and habitat manipulation. The ability to use regulations effectively depends upon an understanding of fish population dynamics and how the population can be expected to respond under the existing habitat conditions.

Minimum size limits, which prohibit the harvest of fish below some specified length, are generally imposed to lower both angling and total mortality in highly vulnerable populations and to reduce exploitation of fish before they reach sexual maturity. Historically, minimum size limits were implemented to prevent overharvest and depletion of fish stocks and were frequently set to protect juvenile fish until maturity.

Maximum size limits are rare, but in situations with relatively few sexually mature adults or where large numbers of smaller fish exist and the manager intends to increase growth rates, maximum size limits can be beneficial.

Slot limits prohibit harvest from a designated intermediate size range. Harvest below the slot may take advantage of a surplus of recruits and allow additional energy to be channeled into mid-sized fish, which then survive and grow out of the protected range and into the harvestable range.

Creel limits are usually defined as the allowable fish, either in number or weight that can be harvested during a particular time period. Creel limits are instituted so that harvest may be more equitably divided; they also have sociological value since they give the angler a specific target and the satisfaction of catching a limit. Daily creel limits have a high degree of voluntary compliance and are easily enforced.

The ideal catch regulation is one that controls total harvest by fish size group based upon knowledge of the population dynamics of the target species. Such a regulation is termed a quota, which is typically applied on an annual basis. After the established annual quota has been harvested, the fishery for that species is closed to further harvest. Unfortunately, most agencies do not possess the necessary personnel to collect up-to-date harvest information from which to determine when a quota is reached.

Although many underexploited fisheries are managed with continuous open seasons, many agencies close seasons during peak spawning activities to protect spawning fish. Seasons are sometimes also established for the safety of users.

Areas are sometimes closed to fishing to protect or enhance the resource or to protect the user. The seasonal closure of areas to protect certain species brings up the question of whether anglers who fish for other species should be denied access. Closure of areas may be necessary as fish populations are initially established or are re-established following reclamation.



Restrictions on gear are imposed to promote a diversity of fishing experiences and inefficiency of harvest. Gear restrictions are also applicable when a large number of fish are to be released after capture such as when size limit or catch-and-release regulations apply. Gear restrictions, unless used to decrease mortality, should only be considered to meet social, as opposed to biological, objectives.

Pelton, J. Z. 1948. Three years of liberalized fishing at Lake Alma, Ohio. Transactions of the American Fisheries Society 78 : 64-69.

Lake Alma, a 72.5 acre lake in southern Ohio, has been checked for fish production from 1937 through 1947. During 1945-1947 no length limits, bag limits, nor closed seasons were imposed. Test-netting and creel census before and since 1945-1947 indicate no measurable difference in fish populations or in angler's success due to liberalized fishing.

Predmore, H. E., Jr. 1948. Two years of fishing in lakes with liberalized regulations. Michigan Conservation 17(6) : 3, 12.

Quinn, S. and R. Mann. 1999. Recovering rock bass. In-Fisherman 24(2) : 17.

The good news in Missouri is that rock bass populations seem to be improving, following recent regulations to protect them on the Big Piney River, an Ozark stream. In 1995, the regulation established a 9-inch 9-fish daily creel limit on an 11-mile stretch of the river. Mile Roell, a biologist with the Missouri Department of Natural Resources, had found that anglers were mostly catching "goggle eye" in the 7-inch class, suggesting that they were overfished.

Department biologists have been sampling the experimental stretch and also a portion without the length and creel limits. So far, the regulations appear to be helping grow bigger rock bass. The study also involves examining smallmouth bass populations, as the two species compete for a forage base of crayfish and are the most popular gamefish in the area. If rock bass increase, might smallmouths decline? The investigation will continue to check long-term changes in rock bass and smallmouth populations, and crayfish abundance.

Redmond, L. C. 1986. The history and development of warmwater fish harvest regulations. p. 186-195 In G. E. Hall and M. J. Van Den Avyle [eds.]. Reservoir Fisheries Management: Strategies for the 80s. American Fisheries Society. Bethesda, Maryland.

Earliest fish harvest regulations in the United States were directed at eliminating fish traps, nets and seines, particularly near mouths of streams and during spawning season. By the early 1900s increasingly restrictive regulations progressed to minimum length limits and closed spring seasons to allow fish to spawn once before being caught. The maximum sustainable yield (MSY) concept was given impetus by subsequent liberalization of regulations after the Norris Reservoir studies showed that fishing could be allowed in the spring without affecting reproduction or number of fish harvested in following years. Studies in the 1940s and 1950s continued to support increased sport fish harvest. Investigations in the 1960s proved that in small lakes predator fishes could be overharvested with little fishing effort, upsetting the "balance" in the fish community and seriously affecting future fishing quality for both predators and panfish. The imposition of effective size limits prevented predator overharvest and maintained



balanced fish populations that provided good fishing. With the use of refined fish tagging and recovery methods, biologists demonstrated that high exploitation rates of black bass and white crappie also occurred in large reservoirs. Harvest restrictions applied to large reservoirs in the 1970s showed that practical, properly applied and well-enforced size limits could maintain sport fishing and harvest of desirable quality in large impoundments as well. One challenge of the '80s is to increase public acceptance of harvest restrictions and to achieve necessary compliance. Both are required to maintain high quality fishing for a growing number of more knowledgeable and better equipped sport fishermen.

Schneider, J. C. and R. N. Lockwood. 1979. Effects of regulations on the fisheries of Michigan lakes, 1946-65. Fisheries Research Report No. 1872. Michigan Department of Natural Resources. Ann Arbor, Michigan. 240 p.

Creel census statistics and related data, collected from 1946-65, are presented for 22 Michigan lakes where sport fishing regulations were tested. The main objective was to determine if increased fishing opportunities could be provided without damaging the populations or their fisheries. For panfish, removal of the closed spring season, removal of the 6-inch size limit, and removal of creel limits were tested. For game fish, length of the closed spring season, both high and low size limits, and a ban on northern pike spearing were tested. For rainbow trout stocked in lakes, spring and winter fishing seasons were tested. Most of the lakes were of the largemouth bass-bluegill type.

It was difficult to accurately discern the effects of the fishing regulations because of imprecise statistics, a large increase in fishing pressure following World War II, a widespread increase in fishing for bass coupled with a decrease in fishing for panfish during the 1950's, irregular recruitment, and other uncontrolled events. It is clear that, in general, no dramatic changes in fisheries or populations resulted; however, some experienced a gradual deterioration which may or may not be linked to the tests. It is recommended that game fish size limits and closed seasons be retained on most lakes in Michigan.

Pumpkinseeds, rock bass, black crappie, and in some lakes largemouth bass and smallmouth bass, were especially vulnerable to spring fishing. Size limits typically had strong effects on the catches of bass and northern pike.

Snow, H. E. 1982. Hypothetical effects of fishing regulations in Murphy Flowage, Wisconsin. Technical Bulletin No. 131. Wisconsin Department of Natural Resources. Madison, Wisconsin. 20 p.

This paper summarizes the hypothetical effects of bag, season, and size limits on the harvest of panfish, northern pike, and largemouth bass in Murphy Flowage, Wisconsin. Complete angler records were obtained through a compulsory registration-type creel census for 15 years. There were no bag, season, or size limits in effect at any time during the study. The hypothetical reduction in harvest with various regulations was calculated from detailed harvest records.

The present bag limits in effect for most of Wisconsin would have had little effect on the observed harvest in Murphy Flowage. A 50-fish daily bag limit on panfish in aggregate would have reduced the observed harvest 2.9% in summer and 13.8% in winter. A 5-fish daily bag limit on gamefish would have reduced the northern pike harvest 0.5% in



summer and 1.5% in winter, while the harvest of largemouth bass would have reduced 2.5% in summer, with no effect in winter.

A year-round open season would have had very little effect on the harvest. A maximum of 7% of the northern pike and 4% of the largemouth bass were taken during the normal closed season, March 1st to the 1st Saturday of May. A later opening date could have a marked effect on the harvest, especially on largemouth bass since 50% of the annual harvest was taken by the end of June.

Size limits alone or in combination with later opening dates had the most potential for reducing the observed harvest. An 18-inch limit on northern pike would have reduced the harvest 22% and a 10-inch limit on largemouth bass would have reduced bass harvest 27%. A slot-length limit of 18-22 inches on northern pike would have reduced the harvest 40% while a 12- to 15-inch limit on largemouth bass would have reduced bass harvest 30%.

Some important considerations in the use of length limits are:

- the possibility of losses of the protected sizes due to hooking mortality;
- possible alteration of the sex ratio of northern pike populations;
- lack of control of forage species by bass if their preferred diet of crayfish is abundant; and
- the possibility of reduced growth rates.

Other in-depth exploitation and mortality studies in Murphy Flowage have shown that the difference in total mortality with fishing and without fishing is relatively small. Therefore, it was concluded that liberalized regulations within the range of fishing pressure and exploitation experienced in Murphy Flowage were not a detriment to the fish populations, and that the hypothetical results of various regulations closely approximated those that would have been obtained with normal regulations.

Wagner, W. C. 1984. Special regulations to establish balanced bluegill and largemouth bass populations. Final Report. Michigan Department of Natural Resources. Ann Arbor, Michigan. 20 p.

Wiley, R. 1978. The rationale of fishing regulations. Wyoming Wildlife 42(9) : 21-26.

Zumbo, J. 1974. We catch big desert bluegill. Outdoor Life 154 : 68-71, 94, 96.

Pelican Lake in eastern Utah's Uintah County served as a big stock watering pond and irrigation reservoir until 1954, when fisheries biologists decided to introduce warmwater species. Bass and bluegill fingerlings were stocked.

Although there is extensive predation by the lake's large bass population, bluegills are so prolific that the bass can't keep up with them. More importantly, big bluegills school according to size classes, and when a bluegill gets to be five or six inches it is too big for the average bass to eat. Then sheer competition for food develops within the school, and unless the bluegills are kept well thinned by anglers they'll soon crowd themselves out. There is no size or possession limit on bluegills at Pelican Lake.



Open/Closed Seasons

Christie, W. J. 1978. Seasonal and area controls. p. 15-16 *In A Study of Freshwater Fishery Regulation Based on North American Experience. FAO Fisheries Technical Paper No. 180. Food and Agriculture Organization of the United Nations. Rome, Italy.*

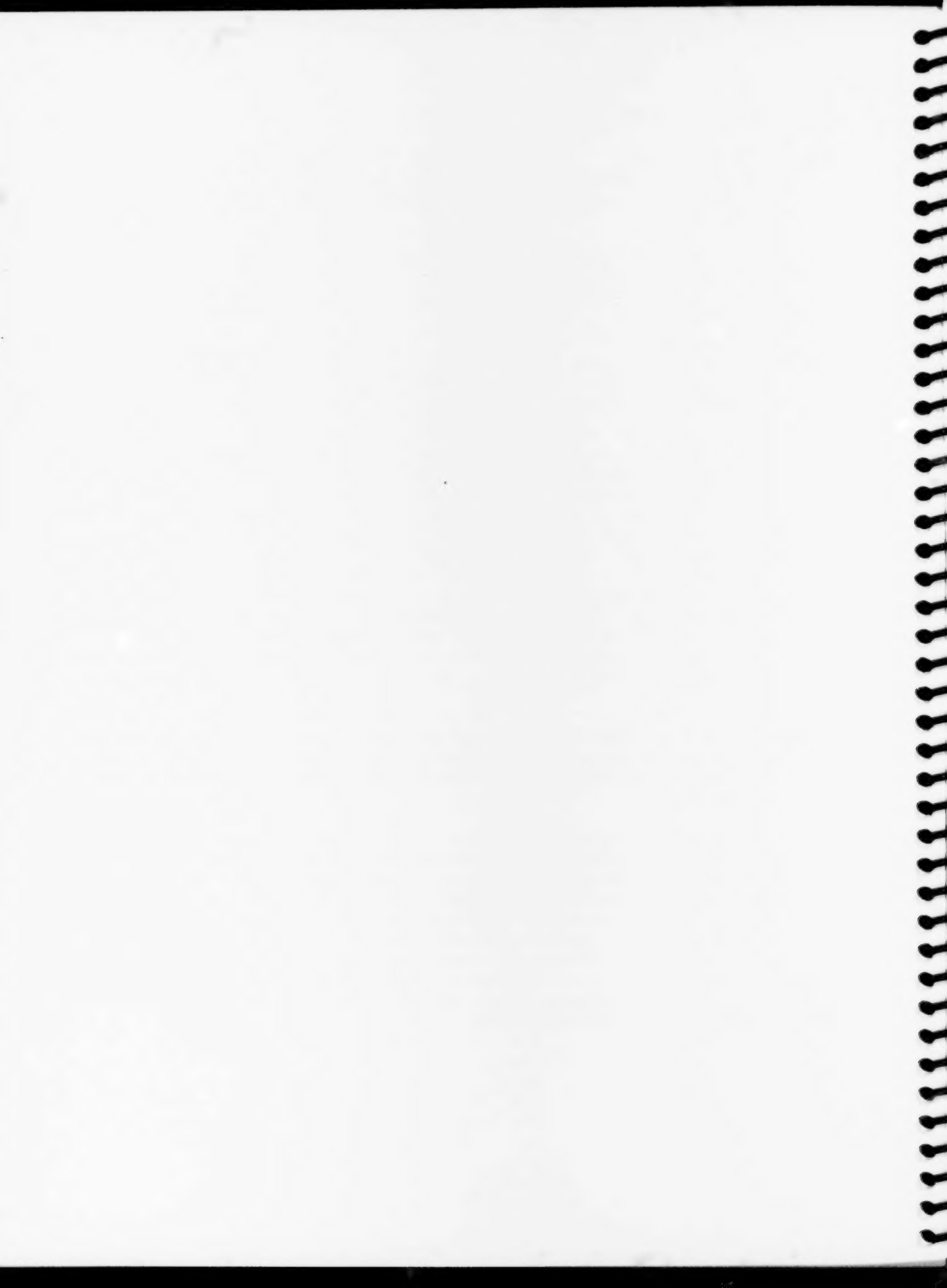
Fishing seasons seldom limit harvest in a significant way. Technically, the time of year a fish is caught has little to do with the perpetuation of the stock to which it belongs. Species which provide early care for eggs and young offer an exception to the generalization.

Schneider, J. C. 1971. Angling on Mill Lake after a 5-year period of no fishing. Research and Development Report No. 253. Michigan Department of Natural Resources. Ann Arbor, Michigan. 14 p.

Mill Lake, a 136-acre warmwater lake in Washtenaw County, Michigan, was closed to fishing from October 1, 1964 to August 1, 1969, for a study of fish population dynamics. This is a report on the creel census conducted the first 3 days the lake was reopened to angling, August 1-3, 1969. The average catch-per-hour was 1.1. For other southern Michigan lakes the average was 1.0. Although this difference appears to be slight, the latter average includes the months of June, July and September which are better times to fish than August. Exploitation of game fish in the lake was disproportionately high. The presumed annual quota (35%) of largemouth bass was harvested from Mill Lake with one-third the expected effort. Exploitation of pumpkinseed sunfish and perch was, likewise, very high for the amount of effort expended. About one-half of the usual annual quota of bluegills and black crappies was taken during the 3 days. However, there appears to be little danger of a serious depletion of the fish population. As fishing quality drops, due to a decline in stock and to a decrease in catchability, fishing pressure also declines.

Varley, J. D. 1976. Yellowstone National Park fishing regulations – Biological benefits and liabilities. 2. Length of Fishing Seasons. p. 149 *In Proceedings of the 56th Annual Conference of the Western Association of Game and Fish Commissioners. Sun Valley, Idaho.*

Yellowstone National Park has what may be the most restrictive regulations pertaining to sport fishing of any of the western states. Yellowstone's general fishing season begins in late May and continues through October. The season length and timing undoubtedly evolved because the Park was historically closed both officially and by snow for most of the year. Presently there are four opening dates: the general season on May 28th, Yellowstone Lake on June 15th, the catch-and-release portion of the Yellowstone River on July 15th, and the tributaries to Yellowstone Lake on August 1st. Each of the opening dates with the exception of the general season are biologically based and came about as a result of information indicating a need to protect spawning fish. Each has appeared successful in accomplishing that goal.



Catch and Possession Limits

Anonymous. 1997. New redear sunfish regulation to start on Merritt's Mill Pond.
<http://www.floridaconservation.org/fishing/news-rel/st-merr.html>

The FWC has established a 14 inch minimum size limit and a five fish daily bag limit for "redears," also known as shellcrackers, on the 202 acre fish management area. This action to restore a failing fishery represents the first reduced bag limit or size limit on redear in Florida. Merritt's Mill Pond's habitat is unique to Florida in that it has extremely clear and hard water which supports a large snail population – the primary food supply for redear. The new rule will produce a trophy redear fishery by allowing fish to survive early harvest, live longer and utilize the abundant food supply to grow to a larger size.

Anonymous. 2002. Sunfish regulations in effect on Mississippi.
<http://www.winonapost.com/042802/outdoor.html>

A sunfish daily and possession limit of 10 is in effect for anglers fishing Mississippi River pools 5, 5A and 8, according to a reminder issued today by officials of the Minnesota Department of Natural Resources. The goal of this special regulation, which began Nov. 1, 2001, is to increase the number of large bluegill (7 inches to 9 inches long) by reducing the annual harvest.

Allen, K. R. 1955. Factors affecting the efficiency of restrictive regulations in fisheries management. II. Bag limits. New Zealand Journal of Science and Technology 36: 305-334.

Allman, J. 2001. Evaluating the use of length and daily limits to maintain a quality bluegill fishery at a heavily fished lake. American Fisheries Society Annual Meeting 131 : 202.

Quality bluegill populations are difficult to maintain under heavy fishing pressure. Large male bluegill are vulnerable to angling when nesting. Experimental length and daily limits have been imposed at Tobacco Hills Lake (17 acres) since 1995. Located less than 20 miles from downtown Kansas City, heavy fishing pressure was expected. A minimum length limit of eight inches was paired with a daily limit of eight to protect large bluegill. The largemouth bass population was protected with a 15 inch minimum length limit. An average of 65 bass, 8 inches or larger, per acre was maintained over the evaluation period to limit overpopulation of bluegill. Yearly sampling occurred during the spring nesting period from May through early June. At least six sampling trips were completed each year. Sampling consisted of nighttime electrofishing. Length frequency analysis was completed for each year's data and compared with previous years. Age and growth data were also collected. After five years, the bluegill population still provides quality fishing. An RSD (8) between 8% and 23% was maintained over the 5 year period with an RSD of 20% in 2000. The original population has been completely replaced under these regulations without a loss of quality.

Ashley, K. W. and R. T. Rachels. 1998. Changes in redbreast sunfish population characteristics in the Black and Lumber rivers, North Carolina. Proceedings of the Annual Conference Southeast Association of Fish and Wildlife Agencies 52 : 29-38.

The objective of this study was to document changes in catch rates (fish/hour) and size structure of the redbreast sunfish (*Lepomis auritus*) populations in the Black and Lumber rivers, North Carolina, over a 4-year period following implementation of a 12-fish daily creel limit. Using boat-mounted electrofishing gear, 123, 122, 94, and 59 redbreast sunfish were collected from the Black River from 1994 through 1997. Numbers of redbreast sunfish collected from the Lumber River during the same years were 257, 252, 164, and 183. Mean CPUE for Black River redbreast sunfish was 18, 19, 16, and 7 fish/hour from 1994 through 1997. Proportional stock density (PSD) values for redbreast sunfish in the Black River exceeded 25 in all 4 years of the study while PSD values for Lumber River redbreast sunfish exceeded 45. Based on these values, the redbreast sunfish populations in both systems would be categorized as supporting quality-size individuals. RSD200mm values for Lumber River redbreast sunfish of 13 (1994) and 28 (1995) would suggest an exceptional redbreast population in this system.

Breining, G. 2002. Field Notes: Lower limits.
<http://www.dnr.state.mn.us/volunteer/marapr02/limits.html>

The DNR is proposing rules to lower bag limits for crappies, sunfish, lake trout, and catfish. The new regulations, if approved, would take effect with the 2003 fishing season. Sunfish have declined in size. There was little public support for lowering the limit to 10. Most anglers indicated they would accept a limit of 20, which biologists believe may help slow the decline of average size.

Cook, M. F., T. J. Goeman, P. J. Radomski, J. A. Younk and P. C. Jacobson. 2001. Creel limits for Minnesota: A proposal for change. Fisheries 26(5) : 19-26.

Recent research has indicated that creel limits are largely ineffective in regulating recreational fish harvest in Minnesota. Current creel limits give an unrealistic picture of the biological capabilities of Minnesota's fisheries and less than 5% of angler trips culminate with the harvesting of a creel limit. We present evidence that high creel limits may cause anglers to have unrealistic expectations of their potential harvest. When fishing success expectations are not met, the result is often dissatisfied anglers. We propose reducing creel limits to more appropriate levels by using a probability angling management strategy. These new limits would be based on past recreational harvest data from completed angler trips. Our goal is to select creel limits that more anglers could attain or come closer to attaining. Over time, we anticipate reduced creel limits would function more as an educational tool and may help anglers develop more realistic expectations of Minnesota's fisheries.

Hess, T. B. 1991. The impact of daily creel limits on sport fish harvest in Georgia. Proceedings of the Annual Conference Southeast Association of Fish and Wildlife Agencies 45: 282-287.

Completed trip information was analyzed from 6 access-type creel census surveys in Georgia to evaluate the impact of state-wide creel limits on restricting sport fish harvest. Interview data from 3 river surveys (1988) and 3 reservoir surveys (1 in 1985 and 2 in 1988) were analyzed to determine what percent of anglers caught the daily limit for



largemouth bass (*Micropterus salmoides*), crappie (*Pomoxis* spp.) and sunfish, and to determine what percent of anglers would be affected by various daily creel limits for these species and for catfish (*Ictalurus* spp.), which currently have no creel limit. Results indicated that current Georgia daily creel limits do not significantly reduce sport fish harvest, as harvests of <1% of anglers approached the creel limits for the 3 groups of fish studied. Access-type creel surveys can be of great value in monitoring or predicting the impact of altered creel limits of anglers as well as on fish populations.

Larsheid, J. G. 1993. Effect of bag limit restrictions on panfish in the Iowa Great Lakes. Abstracts of the Midwest Fish and Wildlife Conference 55 : 209.

Various fishing organizations and anglers have been calling for more restrictive panfish regulations in Iowa. Currently, in Iowa, there is a 25-per-day bag limit for yellow perch (*Perca flavescens*) and no bag limit restrictions for bluegill (*Lepomis macrochirus*) and crappie (*Pomoxis* spp.). The most common suggestion by anglers was to reduce the daily bag limit for yellow perch and to implement similar bag limit restrictions for bluegill and crappie. In general, the perceived need for these regulations was to reduce the probability of overharvest of panfish. This investigation assessed the effectiveness of reducing harvest of yellow perch and bluegill by implementing various bag limit scenarios. Since 1980, an intensive, expandable creel survey was conducted on Spirit and the Okoboji Lakes. Based on these data the actual proportion of anglers catching between 0 and 25 or more panfish was determined in these lakes. Regression models were developed to predict the percent reduction in harvest of panfish for various bag limit restriction scenarios. These models were very precise and explained between 94% (yellow perch model) and 97% (bluegill model) of the variation in harvest reductions. To reduce harvest significantly, bag limits would have to be reduced to 5 fish per day. It was concluded that recruitment, not regulations, was the key factor regulating panfish populations in these lakes.

Porch, C. E. and W. W. Fox, Jr. 1990. Simulating the dynamic trends of fisheries regulated by small daily bag limits. Transactions of the American Fisheries Society 199 : 836-849.

We developed an algorithm for simulating the effects of potential bag limits. The algorithm uses statistical distributions to model the frequency distribution of catch-per-trip. The moment equations of the distribution are keyed to stock abundance and the coefficient of fishing mortality rate, which allow the model to reflect the dynamics of the fishery. The catch with the bag limit is calculated by censoring the simulated distribution. We establish the conditions under which compounded Poisson distributions, such as the negative binomial, can be expected to provide adequate models for the catch distributions of recreational fisheries. We also discuss the assumptions that underlie the method of censoring catch-per-trip distributions and, where appropriate, suggest alternative methods. An example is developed in which we use the negative binomial distribution to model catch-per-trip and the familiar exponential model to simulate the change in stock abundance due to fishing mortality.

Varley, J. D. 1976. Yellowstone National Park fishing regulations – Biological benefits and liabilities. 3. Creel Limits. p. 150 In Proceedings of the 56th Annual Conference of the Western Association of Game and Fish Commissioners. Sun Valley, Idaho.

Yellowstone National Park has what may be the most restrictive regulations pertaining to sport fishing of any of the western states. At the present time, creel or bag limits range

from zero (catch-and-release fishing) to two fish per day or in possession. We have documented a one-third decrease in the annual kill on several waters when the bag limit was reduced from three to two. Under zero bag limits, sportfishing has measurably improved after three years of catch-and-release fishing on a portion of the Yellowstone River.

Wattendorf, B. 1997. Proposed new regulations will help the "other" fish.
<http://floridafisheries.com/updates/new-regs.html>

To enhance panfish angling, in urban lakes, a proposed rule would reduce the bag limit to 20 panfish, other than crappie. Additionally, certain specific small, community or urban lakes will have a minimum length of 8 inches for bluegill and redear sunfish proposed.

Size Limit Regulations

Anonymous. 1997. New redear sunfish regulation to start on Merritt's Mill Pond.
<http://www.floridaconservation.org/fishing/news-rel/st-merr.html>

The FWC has established a 14 inch minimum size limit and a five fish daily bag limit for "redears," also known as shellcrackers, on the 202 acre fish management area. This action to restore a failing fishery represents the first reduced bag limit or size limit on redear in Florida. Merritt's Mill Pond's habitat is unique to Florida in that it has extremely clear and hard water which supports a large snail population – the primary food supply for redear. The new rule will produce a trophy redear fishery by allowing fish to survive early harvest, live longer and utilize the abundant food supply to grow to a larger size.

Allen, K. R. 1955. Factors affecting the efficiency of restrictive regulations in fisheries management. I. Size limits. New Zealand Journal of Science and Technology
35 : 498-529.

Allman, J. 2001. Evaluating the use of length and daily limits to maintain a quality bluegill fishery at a heavily fished lake. American Fisheries Society Annual Meeting
131 : 202.

Quality bluegill populations are difficult to maintain under heavy fishing pressure. Large male bluegill are vulnerable to angling when nesting. Experimental length and daily limits have been imposed at Tobacco Hills Lake (17 acres) since 1995. Located less than 20 miles from downtown Kansas City, heavy fishing pressure was expected. A minimum length limit of eight inches was paired with a daily limit of eight to protect large bluegill. The largemouth bass population was protected with a 15 inch minimum length limit. An average of 65 bass, 8 inches or larger, per acre was maintained over the evaluation period to limit overpopulation of bluegill. Yearly sampling occurred during the spring nesting period from May through early June. At least six sampling trips were completed each year. Sampling consisted of nighttime electrofishing. Length frequency analysis was completed for each year's data and compared with previous years. Age and growth data were also collected. After five years, the bluegill population still provides quality fishing. An RSD(8) between 8% and 23% was maintained over the 5 year period with an RSD of 20% in 2000. The original population has been completely replaced under these regulations without a loss of quality.



Clark, R. D., Jr. and R. N. Lockwood. 1990. Population dynamics of bluegills subjected to harvest within the 5.0- to 6.9-inch range. Fisheries Research Report No. 1961. Michigan Department of Natural Resources. Ann Arbor, Michigan. 17 p.

We conducted a nine pond experiment to test the effects of exploiting bluegills (*Lepomis macrochirus*) under a slotted size limit. For 5 years, bluegills from 5.0 to 6.9 inches were harvested annually via pond draining at three rates (0%, 25%, and 55%), in three ponds each. The 0% harvest rate was considered the experimental control. Density, size structure, growth, mortality, harvest, and reproduction of bluegills were monitored in each pond to help describe specific details of the population dynamics. The mean standing crop (weight/area) of bluegills larger than 7 inches was significantly greater ($P < 0.05$) in 25%-harvest ponds than in 0% or 55% harvest ponds, but we think this might have been due to chance differences in initial stocking rates. Even after 5 years, all fish over 7 inches in the ponds were survivors from the initial stocking. No significant differences were found between harvest rates for mean standing crops of bluegills 5.0 to 6.9 inches or less than 5.0 inches. From the standpoint of fishery potential, bluegill size structures that developed in all experimental ponds would be classified as stunted. Bluegills smaller than 6.0 inches made up over 99% of the populations by number and 93% to 97% by weight. Natural mortality of bluegills was density independent, but individual growth rate and population reproductive success were density dependent. Reproductive success was highly variable and not related to harvest rate. Reproduction failed in 22 of 45 year/pond combinations. Stepwise multiple-linear regression showed that reproductive success was negatively correlated with density of 1.0 to 3.9 inch bluegills (possibly representing predators or competitors of newborn fish), positively correlated with density of 5.0 to 5.9 inch bluegills (possibly representing the majority of sexually mature females), and positively correlated with density of 9.0 inch-plus bluegills (possibly representing the majority of reproductively fit males). In conclusion, bluegills possessed two qualities which made their populations unstable and which led to size structures unsuitable for good fishing: 1) 1.0 to 3.9 inch fish had the ability to avoid starvation and survive at high densities for several years while growing slowly; and 2) 4.0-inch-plus fish had the ability to reproduce large year classes whenever density of small fish was low. Normal sportfishing cannot directly affect either one of these things. Hence, we believe special fishing regulations, if applied directly to bluegills, could not be effective in correcting or preventing overpopulation and stunting. Rather, special fishing regulations should be designed to maintain high densities of predators which might be able to reduce survival and abundance of 1.0 to 3.9 inch bluegills and prevent stunting.

Conover, D. O. and S. B. Munch. 2002. Sustaining fisheries yields over evolutionary time scales. *Science* 297 : 94-96.

Regulatory measures often impose minimum size or gear regulations that ensure selective harvest of larger fish. Such harvesting practices could favor genotypes with slower growth, earlier age at maturity, or other changes that would lower population productivity. In wild, exploited populations, increases resulting from lower fish density may at first obscure the genetic response to selection, unlike in our experiments where density was standardized. Our study illustrates how well-intentioned management plans that appear to maximize yield on ecological time scales may have the opposite effect after accounting for evolutionary dynamics.

What forms of management might help to reduce or incorporate evolutionary changes due to selective fishing? First, the establishment of no-take reserves or marine protected areas may, if properly designed, provide for the maintenance of natural



genetic variation by allowing a portion of the stock to express an unconstrained range of sizes and growth. Second, reliance on minimum size restriction (all fish below a given size are protected) as a basis for management needs rethinking. Where feasible, maximum size limits (all fish above a given size are protected) may offer some important advantages: (i) fast-growing genotypes that pass more quickly through the period of vulnerability would be favored by selection; (ii) the age structure would broaden thereby increasing spawning stock biomass; and (iii) the ecosystem services provided by large animals would be restored. Harvest regimes that account for the Darwinian effects of fishing need serious consideration if yields are to be truly sustainable.

Farabee, G. B. 1974. Effects of a 12-inch length limit on largemouth bass and bluegill populations in two northeast Missouri lakes. p. 95-99. In J. L. Funk [ed.]. Symposium on Overharvest and Management of Largemouth Bass in Small Impoundments. American Fisheries Society. Des Moines, Iowa.

Both Deer Ridge and Wakonda lakes have high numbers of slow-growing bass. In 1965, 6% of the sampled bass in Deer Ridge were between 8.9 and 11.9 inches long; in 1973, 60% were within this range. Wakonda is similar; in 1965, 11% were between 8.9 and 11.9 inches; in 1973, 42% were within this range. This may suggest a buildup of bass numbers which could be attributed to the length limit. Larger bluegills are becoming common in Deer Ridge. Prior to the length limit establishment, 7 inch bluegills were scarce, but since its enforcement 7 inch bluegills are becoming common. Wakonda had large numbers of bass present before a length limit was imposed and larger bluegills were present. Because of this, at Wakonda Lake, little effects of a length limit can be seen on the bluegills.

Paukert, C. P., D. W. Willis and D. W. Gabelhouse, Jr. 2002. Effect and acceptance of bluegill length limits in Nebraska natural lakes. North American Journal of Fisheries Management 22 : 1306-1313.

Bluegill (*Lepomis macrochirus*) populations in 18 Nebraska Sandhill lakes were evaluated to determine if a 200 mm minimum length limit would increase population size structure. Bluegills were trap-netted in May and June 1998 and 1999, and a creel survey was conducted during winter 1998-2001 on one or two lakes where bluegills had been tagged to determine angler exploitation. Thirty-three percent of anglers on one creel lake were trophy anglers (i.e., fishing for large ≥ 250 mm bluegills), whereas 67% were there to harvest fish to eat. Exploitation was always less than 10% and the total annual mortality averaged 40% across all 18 lakes. The time to reach 200 mm ranged from 4.3 to 8.3 years. The relative stock density of preferred-length fish increased an average of 2.2 units in all 18 lakes with a 10% exploitation rate. However, yield declined 39% and the number harvested declined 62%. Bluegills would need to reach 200 mm in 4.2 years to ensure no reduction in yield at 10% exploitation. Both yield and size structure were higher with a 200 mm minimum length limit (relative to having no length limit) only in populations with the lowest natural mortality and at exploitation of 30% or more. Although 100% (N = 39) of anglers surveyed said they would favor a 200 mm minimum length limit to improve bluegill size structure, anglers would have to sacrifice harvest to achieve this goal. While a 200 mm minimum length limit did minimally increase size structure at current levels of exploitation across all 18 bluegill populations, the populations with the lowest natural mortality and fastest growth provided the highest increase in size structure with the lowest reduction in yield and number harvested.



Ricker, W. E. 1945. A method of estimating minimum size limits for obtaining maximum yield. Copeia 1945(2) : 84-94.

The "critical size" for a year class of fish is defined as the size at which the average instantaneous rate of natural mortality begins to exceed the average instantaneous rate of increase in weight. Assuming that what is true of the year class as a whole is also true, on the average, of the fish individually, the critical size can be used as a basis for estimating the best minimum size at which fish should be taken in order to achieve maximum production at the existing rate of fishing. The best minimum size varies with the rate of fishing, being zero when the latter is very small and approaching the critical size when fishing is very intensive. Possible secondary effects of a change in fishing intensity on the rate of growth of the fish make it unwise to extrapolate too far from existing conditions (i.e., the critical size may change). However such extrapolation is a useful guide to the minimum size which will probably be desirable following a moderate change in rate of fishing.

Schneider, J. C. 1973. Response of the bluegill population and fishery of Mill Lake to exploitation rate and minimum size limit: A simulation model. Fisheries Research Report No. 1804. Michigan Department of Natural Resources. Ann Arbor, Michigan. 18 p.

Smith, K. D. 1981. General numerical model for evaluating size limit regulations with application to Michigan bluegill (*Lepomis macrochirus*). M. Sc. Thesis, University of Michigan. Ann Arbor, Michigan. 98 p.

Model developed and applied to a slow, average and fast growing bluegill population. It predicts the outcome of slot, minimum and maximum size limit regulations on catch, population structure and size distribution.

Fish Sanctuaries

Hill, T. K. and E. W. Shell. 1975. Some effects of a sanctuary on an exploited fish population. Transactions of the American Fisheries Society 104(3) : 441-445.

A 10.3 hectare impoundment at Auburn, Alabama, was stocked with bluegill (*Lepomis macrochirus*), redear sunfish (*L. microlophus*), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*) and fathead minnow (*Pimephales promelas*) at densities of 1,852, 617, 247, 247 and 2,470 per hectare, respectively, during December, 1965 to June, 1966. When the impoundment was opened to public fishing in May 1967, half the shoreline and 90% of the impounded area were closed to fishermen. Compared with typical non-sanctuary ponds under similar fishing pressures, the initial catch rates of bass and sunfish were lower in the sanctuary pond. The presence of the sanctuary did not reduce the total catch per hectare, but the catch was spread over a longer fishing season.



Noble, R. L. and T. W. Jones. 1999. Managing fisheries with regulations – Closed areas. p. 463-464. In C. C. Kohler and W. A. Huber [eds.]. Inland Fisheries Management in North America. American Fisheries Society. Bethesda, Maryland.

Areas are sometimes closed to fishing to protect the user. Areas may also be closed to protect or enhance the resource particularly during periods of fish concentration on spawning or nursery grounds when they are very vulnerable to harvest. It is questionable whether closure of an area is justified to protect a few species. If enforcement is adequate, a regulation prohibiting harvest of species of concern would appear to be more viable than closure of the area to all anglers. Closure of areas may be the best tool to allow initial establishment of fish populations or re-establishment following reclamation.

Varley, J. D. 1976. Yellowstone National Park fishing regulations – Biological benefits and liabilities. 1. Closed Waters. p. 149 In Proceedings of the 56th Annual Conference of the Western Association of Game and Fish Commissioners. Sun Valley, Idaho.

Yellowstone National Park has what may be the most restrictive regulations pertaining to sport fishing of any of the western states. Almost without exception, waters in the Park have been closed for non-fishery oriented reasons. In addition, creel surveys have indicated that fished areas upstream and downstream from closed sections were materially replenished by the emigration of fish, which has improved sport angling measurably.

Special Regulations

Behnke, R. J. 1987. Catch-and-release – The last word. p. 291-299 In Catch-and-Release Fishing A Decade of Experience: A National Sport Fishing Symposium. Humboldt State University. Arcata, California.

Significant progress and widespread implementation of special regulations as a management tool has occurred during the past ten years. That is, the biological or fisheries management basis for special regulations, in addition to the sociological or people management aspect, has been generally recognized and accepted. A current problem concerns agency credibility (or lack thereof) and the proper communication of this credibility to the angling public.

Christensen, K. E. 1950. Liberalized fishing regulations. Michigan Conservation 19(4) : 8-10.

Twelve warm-water lakes in Michigan are being watched with interest by sportsmen and research workers. The more liberal regulations in effect on these lakes are listed in the Fish Law Digest under "Experimental Fishing Regulations." The experiment is being conducted by the Fish Division's Institute for Fisheries Research and is now in its fifth year. The object is to determine whether more fishing for panfish, bass, etc. on warm-water lakes might be provided by removing some of the restrictions, i.e., without impairing fishing quality.

Research men have suggested for years that many of the laws limiting the take of warm-water fish to certain sizes, numbers, or seasons of the year are unnecessary, and even detrimental to the lakes, in respect to their ability to produce good fishing.



The liberalized regulations are being tested on a variety of lakes, some with stunted populations, some with good panfish fishing, some with fair bass fishing. The lakes chosen are all fished heavily enough so that a good test of the regulations is being provided. The tests are directed toward two questions: whether the quality of fishing will be improved on poor lakes, and whether on others good fishing quality will be decreased as a result of increased fishing pressure. The extreme, of removing all regulations and restricting anglers only as to method of fishing, is something which we hope to evaluate in the future on a group of test lakes.

Cooper, G. P. and K. E. Christensen. 1951. Testing new fishing regulations. Michigan Conservation 20(3) : 15, 18-20.

A five-year test on certain lake fishing regulations has just been completed. It is expected that the experimental results will be of value in determining what state-wide changes in fishing laws can and should be made. The intent of these special, experimental regulations was to find out if the waters would support the extra amount of spring fishing without harming the quality of fishing during the usual seasons.

The results of these tests seem to show quite conclusively that extra spring fishing for panfish and other non-game species (bass, pike and trout excluded) can be allowed without seriously affecting the quality of fishing during summer and fall. Although one still might argue, logically, that intensive fishing of bluegills on their spawning grounds in very small lakes and ponds could deplete the species rather seriously, this would not happen generally, or on larger lakes.

Ellis, G. 2001. Should Ontario go barbless? Ontario Out of Doors. March Issue : 54-60.

Many biologists and anglers have embraced barbless hook regulations as a fisheries management tool. There's no doubt in my mind that barbless hooks help reduce handling time when releasing most fish. Without a barb, a hook can penetrate more deeply into the mouth tissue, in some instances slicing into the gill rakers. I've seen large brook trout and salmon bleed to death due to the use of razor-sharp barbless hooks. I believe the use of barbless hooks in Ontario should be a personal choice, not a regulation, just as deciding whether to release a fish or keep it for the table is still a choice, within limits, in most of our fisheries.

Goeman, T.J., D. L. Bonneau, D. Baccante, R. D. Clark, D. W. Willis and G. D. Novinger. 1995. Special fishing regulations for managing freshwater sport fisheries. Fisheries 20(1) : 6-8.

Special fishing regulations are those that differ considerably from province-wide or state-wide regulations. They are designed for site specific application and are useful and effective tools for fishery management when applied on the basis of sound fisheries science. Special regulations should be considered when angling harvest or other factors prevent the attainment of specific management goals. Many perceive special regulations as a panacea for all existing fisheries problems. Others have promoted the use of special regulations that have never been proven effective.



The American Fisheries Society (AFS) policy for special fishing regulations for freshwater sport fisheries encourages:

1. Development of realistic and attainable goals and measurable objectives for a fishery.
2. Involvement of the angling public in all phases of planning, development, and implementation of a special regulation to help ensure public acceptance, support, compliance, and effective enforcement once the regulation is in place.
3. Assessment that includes recognizing fiscal and temporal constraints.
4. Recognition of unforeseen problems that arise during implementation and evaluation of special regulations to further the understanding of site-specific special regulations.
5. Communication of evaluation results to the public and to the professional community.

Wallis, O. L. 1971. Management of aquatic resources and sport fishing in national parks by special regulations. Proceedings of the Annual Conference Western Association of State Game and Fish Commissioners 51: 150-163.

To effectively and successfully implement a management objective or program, special regulations in national parks and elsewhere must adhere to certain criteria. Such criteria include the following principles. Special regulations should be:

1. Established to serve a specific purpose or objective.
2. Limited in number to those actually required.
3. Based upon sound biological principles and derived from adequate investigations or research.
4. So clearly written that their true meaning and intent is understood by the fishermen.
5. Acceptable to the fishermen.
6. Available to the fishermen either by printed notices or booklets or visibly posted.
7. Enforceable and enforced.
8. Periodically reviewed and evaluated to determine if they are effectively achieving the objectives for which they were established; if not, they should be abolished or revised.

Special regulations, by their very limited nature, can create additional administrative responsibilities such as increased law enforcement; the need for expanded public relations to explain the special provisions and their purposes; and added posting and signing. When criteria such as these are not given proper consideration, problems of enforcement and application frequently develop and the special regulations fail to accomplish the intended purposes.

Catch-and-Release Regulations

Barnhart, R. A. 1989. Symposium review: Catch-and-release fishing - a decade of experience. North American Journal of Fisheries Management 9 : 74-80.

This paper provides a synopsis of the 1987 symposium "Catch-and-Release Fishing - A Decade of Experience," gives a brief history of the catch-and-release concept, and presents related research needs. Twenty-three presenters provided current information concerning catch and release of a variety of freshwater and marine sport fish. Catch-and-release fishing was first tried in the Great Smoky Mountains National Park in 1954.



Today, most states and provinces in North America have catch-and-release programs on some waters. Catch-and-release regulations must be selectively applied, productivity of the environment and longevity of the fish are important considerations, and strict compliance with special regulations by anglers is necessary for success. Anglers will accept these regulations when professionals present sound biological evidence to demonstrate the need. An increased use of catch-and-release regulations was reported in non-trout fisheries, especially those for largemouth bass (*Micropterus salmoides*). Traditionally, most saltwater sport fish have not been released but, because of increased pressures on declining stocks, catch-and-release fishing now is promoted by concerned saltwater angler organizations.

Caverhill, P. A. 1977. The B. C. experience in catch-and-release fishing. p. 151-160 In Catch-and-Release Fishing As A Management Tool: A National Sport Fishing Symposium. Humbolt State University. Arcata, California.

In tune with the theme of this symposium, and with specific reference to the fresh waters and species managed by the British Columbia Fish and Wildlife Branch, this paper will address:

1. The current fisheries scene geographical aspects, fisheries management responsibilities, angler population, status of fish stocks.
2. Provincial overview by regions of the use of "catch-and-release" regulations – past, present and future.
3. Angler use and acceptance of "catch-and-release."
4. Mortality considerations of "catch-and-release."

The use, and especially the evaluation of management tools like catch-and-release has just begun in many areas of North America. This is especially true in British Columbia. Our anglers and managers are quickly becoming more sophisticated. Also, the real impact of shrinking habitat for anglers and fish is making itself felt with a vengeance. Much of the specific catch-and-release data that will be presented here are from programs that are less than five years old.

Cooke, S. J., D. P. Philipp, K. M. Dunmall and J. F. Schreer. 2001. The influence of terminal tackle on injury, handling time, and cardiac disturbance of rock bass. North American Journal of Fisheries Management 21 : 333-342.

We studied the effects of catch-and-release angling on rock bass (*Ambloplites rupestris*), a small but common centrarchid species in North America. A field study of hooking injury and mortality was conducted in Lake Erie at a water temperature of 16°C. We captured fish using one of four terminal tackle types: barbless worm, barbed worm, barbless jig, and barbed jig. No mortality was observed in any of the four treatments even after holding fish for 5 days. Fish captured using worms were hooked more deeply than fish caught on jigs. Fish captured on barbless jigs were unhooked most easily and more rapidly than with all other tackle types, resulting in an average of only 20 seconds of air exposure. Because they were more difficult to remove from the hook, fish captured on other terminal tackle experienced at least twice as much air exposure. To assess sublethal effects, we measured the cardiac responses of rock bass exposed to 30 seconds of simulated angling followed by 30 or 180 seconds of air exposure. These air exposure durations were intended to simulate the conditions faced by fish that were either easy or difficult to remove from the hook. Fish experienced arrhythmia during angling, although overall cardiac output increased. Fish experienced severe bradycardia

during air exposure, but after being returned to the water, all fish exhibited elevated cardiac output. Fish exposed to 30 seconds of air exposure required 2 hours for full recovery, whereas those exposed to 180 seconds of air required 4 hours. During periods of cardiac disturbance, increases in cardiac output were due to both heightened heart rate and stroke volume. Our results suggest that hooking mortality did not vary with bait or hook type and that physiological disturbance of rock bass was influenced by the duration of air exposure, as influenced by bait and hook choice. We recommend that anglers attempt to minimize handling and air exposure of angled fish and keep pliers or other hook removal devices readily accessible to facilitate rapid release of fish not intended for harvest.

Quinn, S. 1996. Trends in regulatory and voluntary catch-and-release fishing. p. 152-162
In L. E. Miranda and D. R. DeVries [eds.]. **Multidimensional Approaches to Reservoir Fisheries Management**. American Fisheries Society Symposium 16, Bethesda, Maryland.

Regulations requiring the release of many fish species have increased dramatically. Fisheries management agencies have shifted from viewing harvest regulations as necessary evils to seeing them as popular mandates in the quest for high quality fishing. Voluntary release of legally harvestable fish by anglers also seems to be increasing. This study documents trends in catch-and-release fishing including the increase in regulations for various species, the extent of voluntary release, reasons for increases in catch-and-release fishing, and agency promotion of catch-and-release. A survey of state agencies showed that during the last decade, catch-and-release regulations for trout (*Salmonidae*) have increased 88% of the responding states, and for black bass (*Micropertus* spp.) in 86% of those states. Sixty-seven percent of states reported increases in regulations for walleye and sauger (*Stizostedion* spp.); 52% for (*Morone* spp.); 49% for crappies (*Pomoxis* spp.); 48% for esocids (*Esox* spp.); 39% for salmon; 19% for catfish (*Ictaluridae*) and 17% for sunfish (*Lepomis* spp.). Increases in voluntary release among states ranged from 95% for black bass to 16% for catfish and were similar in scope to increases in regulations. Regulations for catch-and-release increased greatly in some states, but voluntary release increased by smaller percentages. State agencies reported a wide array of biological and sociological reasons for increases in regulatory and voluntary catch and release. Despite the attention to regulations by agencies and great interest in this type of management by anglers, the published literature contains a paucity of case histories or sociological reports on the topic. It seems clear that the role of regulations in managing fish populations and providing recreation for the public will expand. Implementing regulations that will maintain ecosystem integrity successfully and meet society's needs will require greater communication among fisheries managers and between managers and the public about ecological principles and management strategies.

Schneider, J. C. 2001. Evaluation of catch-and-release regulations at Wakeley Lake, 1987-97. Fisheries Technical Report 2001-2. Michigan Department of Natural Resources. Ann Arbor, Michigan. 32 p.

Wakeley Lake has been managed with catch-and-release regulations for all species of fish, walk-in access, and other special rules since it passed from private to public ownership. Major goals were to maintain high-quality populations of largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), and sunfishes (*Lepomis* spp.); maintain high-quality fisheries; and preserve a semi-wilderness setting. Surveys of fish populations were conducted prior to public access in 1986 and 1987, and after public



access and special regulations were in effect in 1990 and 1997. Surveys of angling were conducted in 1987, 1990, and 1997, during the first, fourth, and eleventh years of public fishing. Trends in population and angling data indicated the largemouth bass population and fishery have been maintained or improved. Northern pike numbers and fishing quality diminished during the 1990s but the population has the same size structure. Bluegill (*Lepomis macrochirus*) and pumpkinseed (*Lepomis gibbosus*) populations and fisheries remained excellent. However, growth of largemouth bass, northern pike, and bluegill declined during the 1990s. Hooking mortality appeared to be very low. Extensive recycling of largemouth bass and northern pike was evidenced by frequency of tag returns and annual angling catches exceeding estimated spring populations by factors of 2-3 times. Anglers visiting the lake consistently expressed strong support of the regulations at Wakeley Lake and catch-and-release angling in general. These regulations have been very successful and should be continued at Wakeley Lake. The same management concepts should be extended to other lakes with equivalent opportunities.

Schneider, J. C. and R. N. Lockwood. 1997. Experimental management of stunted bluegill lakes. Fisheries Research Report No. 2040. Michigan Department of Natural Resources. Ann Arbor, Michigan. 76 p.

A cooperative 8 year study was conducted by fisheries managers and researchers to evaluate three techniques for improving stunted bluegill (*Lepomis macrochirus*) populations in 12 southern Michigan lakes. Four other lakes served as controls. Three years of pre-treatment and 6 years of post-treatment data were collected on bluegill growth, size structure, and recruitment. The techniques tested were (a) treatment with the selective toxicant antimycin to thin-out small bluegills; (b) stocking large fingerling walleye (*Stizostedion vitreum*) to thin-out small bluegills by predation; and (c) catch-and-release regulations to protect predators and large bluegill. The four treatment groups, each with three replicates, were: antimycin-only, walleye-only, antimycin + walleye, and antimycin + catch-and-release.

All treatment lakes except two showed some response in bluegill growth or size structure to the treatments. In those two lakes apparently insufficient numbers of bluegill were thinned-out by antimycin treatments to elicit a response. By contrast, bluegill population characteristics of control lakes were relatively constant through time. For 2/2 antimycin-only lakes, bluegill populations improved immediately, but only slightly, and benefits lasted for 2-6 years. Populations then reverted to slow growth and sparse numbers of bluegill 7 inches and larger. The antimycin effect was similar in other lakes which had been treated in combination. For 3/3 walleye-only lakes, bluegill populations improved considerably as a delayed response evident by the 5th year after stocking and persisting through the last year of study (6th). For 2/2 antimycin + walleye lakes, bluegill showed a combination of those immediate and delayed responses. Quality of those bluegill populations improved considerably with some 8 inch bluegills generated. Surprisingly, bluegill responses occurred at relatively low densities of walleye. Antimycin + catch-and-release lakes (3/3) showed the best response of all, with enough large bluegill produced to merit ranks of "excellent". However, declining bluegill growth signals that even those lakes may eventually revert.

Study results led to the recommendation that large fingerling walleye be routinely stocked as a tool for improving stunted bluegill lakes. Special regulations to limit harvest are continuing indefinitely at the three former catch-and-release lakes and results will be



monitored to determine if permanent restructuring of the bluegill population and fish community have been accomplished.

Schneider, J. C. and R. N. Lockwood. 2002. Use of walleye stocking, antimycin treatments, and catch-and-release angling regulations to increase growth and length of stunted bluegill populations in Michigan lakes. *North American Journal of Fisheries Management* 22 : 1041-1052.

Three techniques for increasing the growth and length characteristics of populations of stunted bluegills (*Lepomis macrochirus*) were evaluated in 12 southern Michigan lakes. The techniques tested, either singly or in combination, were (1) treatment with the selective toxicant antimycin to directly reduce the densities of small bluegills; (2) stocking large fingerling walleyes (*Stizostedion vitreum*) to indirectly reduce the densities of small bluegills through predation; and (3) catch-and-release fishing regulations to protect predators and large bluegills. Three years of pre-treatment and 6–10 years of post-treatment data were collected on bluegill growth, size structure, and recruitment. Compared with reference lakes, catches of 7.0–7.9 inch bluegills in trap nets and average bluegill growth increased in all but two treatment lakes. Bluegill characteristics in both of the two antimycin-only lakes increased within 1 year, but the increases tended to be short-lived. Bluegill characteristics in all three walleye-only lakes increased considerably as a delayed response that was evident by the fifth year after stocking and persisted thereafter. For both of the two antimycin + walleye lakes, bluegills showed a combination of immediate and delayed responses, but walleye densities were low. For all three of the antimycin + catch-and-release lakes, many large bluegills resulted, which persisted for up to 10 years. Bluegill size structure decreased in one lake when angler harvest was reinstated. Stringent angling restrictions and stocking of large fingerling walleyes were useful tools for prolonged improvement of stunted bluegill lakes.

Slipke, J. 1998. Can catch-and-release regulations shrink fish? *In-Fisherman* 23(1) : 12-13.

The benefits of catch-and-release have prompted management agencies to implement no-harvest regulations to meet angler demands for better fishing. Anglers often expect these regulations to foster more and larger fish. These results indicate that catch-and-release regulations while increasing the abundance of catchable-sized fish may do so at the cost of reduced size, especially in systems with limited forage or in newly impounded reservoirs. Depending on management objectives and angler preferences, that may not be a problem. In some situations, anglers may prefer to sacrifice a higher average size in favor of faster action.

Hooking Mortality

Burdick, B. and R. Wydoski. 1987. Effects of hooking mortality on a bluegill fishery in a western reservoir. p. 187-196 *In* Catch-and-Release Fishing A Decade of Experience: A National Sport Fishing Symposium. Humbolt State University. Arcata, California.

An intense fishery developed for quality-sized bluegills (*Lepomis macrochirus*) (mean total length 212 mm and mean weight 285 g) in 680 hectare Pelican Lake, Utah, between 1966 and 1977 as a result of an increase in anglers moving into the area and



publicity in national outdoor magazines. Estimated angler-days of use increased from 2,959 in 1969 to 10,054 in 1975. Because 58% of the anglers used bait, we attempted to determine the relation of hook size to mortality of bluegills that were released (as the result of the imposition of a 20 bluegill bag limit) and to estimate the loss of released fish from the populations. Hooking mortality was estimated to be 18% for size 8 hooks, 10% for sizes 6 and 10, and 7% for size 4. No mortality was observed in bluegills on size 6 maribou feathered jigs or in fish in which the line was cut, leaving a size 8 hook in place. Nearly two-thirds (63%) of the bluegills that died did so within 24 hours after they were caught, primarily because the hook had penetrated the pericardial cavity (63%), gill, or gill arch (37%). During the 1977 fishing season, anglers creelied 22,907 bluegills and released 5,158. We estimated that 565 of the released bluegills (55.7 kg) died from hooking mortality – an estimated 2.5% of the number and 0.8% of the weight of bluegills harvested in 1977. The estimated angler harvest in 1977 was 18.6% of the August standing crop. Thus, the harvest of 5 and 6 year-old bluegills had a greater influence on the fishery than did hooking mortality.

Cooke, S. J., D. P. Philipp, K. M. Dunmall and J. F. Schreer. 2001. The influence of terminal tackle on injury, handling time, and cardiac disturbance of rock bass. North American Journal of Fisheries Management 21 : 333-342.

We studied the effects of catch-and-release angling on rock bass (*Ambloplites rupestris*), a small but common centrarchid species in North America. A field study of hooking injury and mortality was conducted in Lake Erie at a water temperature of 16°C. We captured fish using one of four terminal tackle types: barbless worm, barbed worm, barbless jig, and barbed jig. No mortality was observed in any of the four treatments even after holding fish for 5 days. Fish captured using worms were hooked more deeply than fish caught on jigs. Fish capture on barbless jigs were unhooked most easily and more rapidly than with all other tackle types, resulting in an average of only 20 seconds of air exposure. Because they were more difficult to remove from the hook, fish captured on other terminal tackle experienced at least twice as much air exposure. To assess sublethal effects, we measured the cardiac responses of rock bass exposed to 30 seconds of simulated angling followed by 30 or 180 seconds of air exposure. These air exposure durations were intended to simulate the conditions faced by fish that were either easy or difficult to remove from the hook. Fish experienced arrhythmia during angling, although overall cardiac output increased. Fish experienced severe bradycardia during air exposure, but after being returned to the water, all fish exhibited elevated cardiac output. Fish exposed to 30 seconds of air exposure required 2 hours for full recovery, whereas those exposed to 180 seconds of air required 4 hours. During periods of cardiac disturbance, increases in cardiac output were due to both heightened heart rate and stroke volume. Our results suggest that hooking mortality did not vary with bait or hook type and that physiological disturbance of rock bass was influenced by the duration of air exposure, as influenced by bait and hook choice. We recommend that anglers attempt to minimize handling and air exposure of angled fish and keep pliers or other hook removal devices readily accessible to facilitate rapid release of fish not intended for harvest.

Muoneke, M. I. 1992. Season hooking mortality of bluegills caught on natural baits. North American Journal of Fisheries Management 12 : 645-649.

Summer and winter hooking mortality rates were estimated for bluegills (*Lepomis macrochirus*) caught in June 1989 in Choke Canyon Reservoir, Texas, and in March 1990 in Cedar Lake Reservoir, Texas. Water temperatures averaged 16.7 and 30°C

during the winter and summer angling experiments, respectively. Fish were caught by angling with size 4 single shank hooks baited with live crickets in the summer and earthworms in the winter. Ninety-five fish (109–193 mm total length) were caught in the winter and 75 fish (146–200 mm) in the summer. Fish were held for 72 hours in 0.79 m² × 1.00 m cylindrical plastic cages to observe delayed mortality. One of 95 fish died in the winter and 19 of 75 fish died in the summer. Hooking mortality was significantly higher in summer than in winter ($P < 0.05$).

Muoneke, M. I. and W. M. Childress. 1994. Hooking mortality: a review of recreational fisheries. *Reviews in Fisheries Science* 2(2) : 123-156.

Length-limit regulations and promotion of catch-and-release fishing have become increasingly important management approaches for recreational fisheries. We review studies on catch-and-release (hooking) mortality gathered from the existing fisheries literature and from a survey of fisheries management agencies in all 50 states, the U.S. government, all Canadian provinces, and selected academic and research institutions. We identified hooking mortality estimates for 32 taxa. Most studies dealt with salmonids, centrarchids (especially black basses, *Micropterus* spp.), and percids (especially walleye, *Stizostedion vitreum*). Within and among species, differences in percent mortality were reported in association with bait type (artificial vs. natural), hook type (number of hooks, hook size, and barbs), season/temperature, water depth (depressurization), anatomical location of hook wound, and individual size. Although most hooking mortalities occur within 24 hours, the use of initial plus delayed mortality provides a more complete estimate of mortality. Single hooks (especially when used in conjunction with natural baits) resulted in higher mortalities than treble hooks. Environmental conditions (notably high water temperature and low dissolved oxygen) are important to overall mortality related to hooking, playing, and handling. Mortalities were highly variable; occasionally exceeding 30% among red drum (*Sciaenops ocellatus*), smallmouth bass (*M. dolomieu*), largemouth bass (*M. salmoides*), cutthroat trout (*Oncorhynchus clarki*), and catfishes (Ictaluridae), and 68% among spotted seatrout (*Cynoscion nebulosus*), bluegills (*Lepomis macrochirus*), crappies (*Pomoxis* spp.), striped bass (*Morone saxatilis*), and coho salmon (*O. kisutch*). Lake trout (*Salvelinus namaycush*) and pikes (Esocidae) had mortalities under 15%. The many variables potentially affecting hooking mortality may make optimal management of particular species and water bodies difficult using regional-level (e.g., state-wide) management regulations.

Powell, M. J. and R. Hawkins. 1994. A review of the mortality of caught-and-released fish. Ontario Ministry of Natural Resources, Central Region. Huntsville, Ontario.

Exploitation is the largest single stress on fish communities in the majority of Ontario's lakes. To control this stress, fisheries managers have traditionally relied on creel limits and season restrictions. For some species there is little room for further creel limit reductions while season restrictions seem to work well to control exploitation, anglers complain that too many fishing opportunities are lost. In order to maintain fishing opportunities but control exploitation managers are becoming increasingly interested in the use of size limits.

Regardless of the type of size limit imposed the success of the regulation hinges largely on the survival rate of the released fish. For this reason a large amount of research has been directed at determining factors that affect post-release mortality. In order to help local managers evaluate size regulations and answer questions from the public the

Central Region has completed a summary of hooking mortality rates and that affect survival of released fish.

Siewert, H. F. and J. B. Cave. 1990. Survival of released bluegill (*Lepomis macrochirus*) caught on artificial flies, worms, and spinner lures. *Journal of Freshwater Ecology* 5 : 407-412.

Effects of three types of terminal gear and anatomical hooking location on mortality of released bluegill were investigated. Worm-baited hooks, artificial flies, spinner baits and seines (control group) were used to catch fish. Bluegill caught with worms had a significantly higher ($P < 0.001$) mortality (88%) than those caught with flies (32%), lures (28%) or seines (12%). All fish hooked in the esophagus, gill, tongue or eye died within 10 days, whereas, the mortality of fish that were hooked in the jaw was 37.5% and in the lip 13%. Worm-baited hooks were ingested deeper than artificial lures and flies. No significant difference in mortality between fly- and lure-hooked fish was observed. These results indicate that bluegills caught on artificial lures have a better chance to survive than those caught with worms.

Warner, K. 1979. Single hook vs. treble hook...Lures vs. flies...What about worms...What we've learned about hooking and releasing fish. *Maine Fish and Wildlife*. Summer : 20-24.

Wydoski, R. S. 1977. Relation of hooking mortality and sublethal hooking stress to quality fishery management. p. 43-87 *In* Catch-and-Release Fishing As A Management Tool: A National Sport Fishing Symposium. Humbolt State University. Arcata, California.

The demand for "quality" angling experiences has been increasing in concert with the increase in the number of anglers in the United States. "Catch-and-release" fishing has been one tool used by fishery managers to produce "quality" angling with the logic that fish will be available to be caught several times and will reach larger sizes since they are allowed to live longer. Under light to moderate angling pressure, this concept works well in managing for quality fishing. However, the factors of hooking mortality or sublethal hooking stress may become important considerations for the manager in catch-and-release fishing programs when pressure is high.

Initial hooking mortality is often linked with the type of terminal gear used by anglers and hook damage to vital organs such as the heart or a gill. Since bait is often taken deeply by fish, this terminal gear has caused the highest mortality in fish (mean 25.0 percent, range 3.3 to 61.5 percent, $N = 2,859$). The average mortality to fish from barbed hooks on lures was 6.1 percent (range 1.7 to 42.6 percent, $N = 3,625$) while barbed hooks on artificial flies caused an average mortality of 4.02 percent (range 0.0 to 11.3 percent, $N = 2,713$). These hooking mortalities were determined in experiments that differed due to variables such as species of fish, size of fish, sample size, type of bait used, hook size, anatomical site of hooking, angling technique, and different water temperatures. Single hooks have usually caused higher mortality than treble hooks when used with bait or lures as the terminal gear. Also, the use of barbless hooks did not significantly reduce mortality when compared to barbed hooks but the use of such hooks reduces handling time of fish that could add to their survival after release.

Stress in fish can disrupt normal metabolic and osmo-regulatory functions in fish and various stresses are cumulative in their affect on fish. Hooking stress does not cause mortality in fish that are in good physiological condition. However, hooking stress added to fish that are already under stress from adverse environmental conditions or pollutants may cause mortality of fish either directly or indirectly by allowing them to become more susceptible to predators, diseases, or parasites. The delayed mortality that results from stress can be more important than the initial hooking mortality that is observed and must be taken into account by fishery managers in quality fisheries if the angling pressure is high or the fish are under adverse or stressful conditions.

The losses of fish to hooking mortality or hooking stress is probably not very important in the productive waters of the United States. However, such losses could be very important to management of quality fisheries in less productive waters such as found in northern United States. In such waters, the most important factors to consider in the overall loss of fish from hooking mortality are species differences in voracity of feeding, type of terminal gear being used by anglers, the anatomical site of hooking, and water temperature.

Fishery biologists may sometimes have the biological facts to solve a particular problem but may not be able to implement the solution because of economical, political, or sociological constraints. Fishery managers should be certain to adequately inform the public about their policies or programs and employ effective public relations to help influence politicians and the public in the proper direction for the best management of U.S. waters for recreational fishing opportunities.

Angler Attitudes and Compliance

Chipman, B. D. and L. A. Helfrich. 1988. Recreational specializations and motivations of Virginia River anglers. *North American Journal of Fisheries Management* 8 : 390-398.

On-site interviews and a mail questionnaire survey of 377 anglers on two Virginia rivers were used to evaluate the concept of recreational specialization for differentiating angler subgroups. Specialization was defined for four dimensions of angler behavior: (1) fishery resource use, (2) experience, (3) investment, and (4) centrality of angling to lifestyle. Six types of anglers, representing low to high levels of specialization, were identified by cluster analysis. The experience dimension was the most important contributor to the framework, accounting for 24% of the variance in the data. A combination of the resource, investment, and centrality dimensions explained 48% of the variance. Highly specialized anglers were likely to cite resource-related motives (e.g., trophy fish), to rely on skill to catch fish, to prefer to catch and release larger fish, and to favor restrictive harvest regulations. Less specialized anglers cited escape and family-oriented recreation as motivations for fishing, placed greater emphasis on luck to catch fish, were satisfied with catching smaller fish, and favored liberal harvest regulations. Our results suggest that certain aspects of angler behavior, particularly frequency of fishing, investment, and consumptive habits, are important determinants of specialization that can be used to identify angler subgroups and to assist managers in maximizing satisfactions among their diverse clientele.



Cunningham, P. K. and C. S. Anderson. 1992. Opinions of angler groups and fisheries professionals in Minnesota. Investigational Report 422. Minnesota Department of Natural Resources. St. Paul, Minnesota. 35 p.

The Minnesota Department of Natural Resources considers angler opinions in setting goals, choosing fish management activities, and in evaluating agency performance. Managers recognize that perspectives vary, yet they lack information on how anglers might respond to management activities or where perspectives differ. The Department therefore surveyed Minnesota resident anglers, nonresident anglers, two types of fishing club members, and fisheries professionals by mail in 1987 to compare angling motivations, opinions of fish management activities, and views of agency policies. Five angling motive components, seven fish management components, and four agency performance components were identified by principal component analyses. For resident anglers, motivations related to nature were strongest, those related to social, catch, and food aspects were less, and social-competitive motives were lowest. Opinions of resident anglers about fish management activities most supported resource protection, with decreasing levels of support for activities related to access, stocking inland, fish removal, stocking Lake Superior, harvest restrictions, and fish size. Groups differed on 14 of the 16 components. Anglers belonging to statewide or nationally chartered fishing clubs (i.e. Bass Federation, Muskies Incorporated, Federation of Fly Fishermen, Trout Unlimited, or Walleyes Unlimited) had relatively low food motives, and high catch and social-competitive motives. They favored resource protection, harvest restrictions, and management for quality-sized fisheries more than resident anglers. Club anglers identified as belonging to local fishing clubs had relatively high social-competitive motives, supported most management activity components slightly more than residents, but joined with other clubs in being most critical of agency performance. Nonresident anglers placed more importance on food and social-competitive aspects of angling than resident anglers did, but were otherwise similar. Fisheries professionals attached even more importance to resource protection than resident and nonresident anglers did, yet their opinions about harvest restrictions were similar to those of local fishing clubs, resident and nonresident anglers. Professionals had lower component scores than other groups on axes related to fish size, stocking Lake Superior, and fish removal. The identification of many differences among groups should guide conflict resolution efforts, educational plans, and moves to obtain representative public participation in the decision making process.

Dean, J. 1996. The role of angler organizations in fisheries management. p. 172-178 In L. E. Miranda and D. R. DeVries [eds.]. Multidimensional Approaches to Reservoir Fisheries Management. American Fisheries Society Symposium 16, Bethesda, Maryland.

Because fishing organizations include concerned and outspoken anglers, they may be perceived as adversaries to resource management agencies. However, explanation and justification of agency actions prior to changes in policies and regulations will facilitate angler support and reduce conflict. I believe that public hearings have traditionally been ineffective in facilitating communication between agencies and angler groups because often they are not held to learn about angler's views on a given issue, but instead to allow agencies to convey decisions that have already been made. Agency personnel should work to understand public priorities and match management and research emphases and resource allocation to meet those priorities. Angler organizations serve to stimulate honest communication between anglers and managing agencies so that benefits to the agency, anglers, and the resource can be optimized.



Duttweiler, M. W. 1976. Use of questionnaire surveys in forming fishery management policy. Transactions of the American Fisheries Society 105(2) : 232-239.

The desirability of incorporating fishermen preferences into management decision-making was identified. A questionnaire survey technique based on a random sample of residents was developed to obtain unbiased assessment of angler preference. The survey technique was tested in the Owasco Lake (New York) watershed.

A random sample of 1,092 Owasco Lake Basin residents was used to evaluate their preference for fishing and fishery management policies. The questionnaire was pre-tested for question effectiveness and clarity. A total of 794 completed forms were returned (73%). Effect of non-responses was estimated through a phone survey of 60 non-respondents. Twenty-nine percent of Owasco Lake Basin households contained Owasco Lake fishermen. Of those who fished at Owasco, 21% preferred lake trout, 17% preferred rainbow trout, 15% preferred walleye, and 47% other species. The most frequently cited reasons for fishing were: "for relaxation," "to get outdoors," and "for fun." The results represent an assessment of fishermen preference in the Owasco Lake locale and cannot be generalized to other areas. However, the questionnaire and sampling techniques that were developed can be used, with minor adaptations, in other recreational fisheries to obtain a systematic evaluation of preference that is far more reliable than casual contacts with sportsmen organizations or individuals.

Gigliotti, L. M. 1985. Illegal harvest: Impact on recreational fisheries. p. 86 In Proceedings of the 47th Midwest Fish and Wildlife Conference. Grand Rapids, Michigan.

The degree of compliance with a regulation could be consequential to its effectiveness. Yet, many fisheries managers do not have sufficient information about compliance with regulations. The purpose of this paper is to give fisheries managers a better understanding of the impact that certain illegal harvest has on sport fisheries.

Two types of illegal harvest were considered: (1) a regular fishery where any fish kept under a certain minimum size is considered illegal harvest, and (2) a catch-and-release fishery where any fish kept is considered illegal harvest. The results show that illegal harvest can very quickly have a significant impact on some regular fisheries. In catch-and-release fisheries, illegal harvest can very quickly have a dramatic impact on the numbers of "legal-sized" fish (fish that would be legal-sized under the regular regulations) caught-and-released by the public. Most of the benefits of a catch-and-release regulation are lost if about 20% of the "legal-sized" fish caught are illegally harvested.

Hampton, E. L. and R. T. Lackey. 1976. Analysis of angler preferences and fisheries management objectives with implications for management. Proceedings of the Annual Conference Southeast Association of Fish and Wildlife Agencies 29: 310-316.

Fisheries managers have long operated under the assumptions that time spent fishing (angler-days) or pounds or numbers of fish caught (maximum sustained yield) were accurate measures of fisheries output. However, many fisheries managers today advocate development of a multidimensional output measure which would incorporate social, aesthetic, and psychological factors. The present study was undertaken to delineate and determine the relative importance of 10 items affecting the quality of

angling as perceived by Virginia fee-fishermen. A self-administered questionnaire employing a modified Likert scale was used to evaluate the 10 quality-related items. A factor analysis was run which resulted in four factors relating to the quality of fee-fishing. The factors were: (1) attractiveness of the fishing site, (2) amount of fishing, (3) satisfaction, and (4) improvements needed. The four factors, when combined with the mean importance scores, indicate that the quality of fee-fishing is multidimensional and not dependent solely on catch.

A portion of the survey was devoted to determining the relative importance of 9 fisheries management objectives as indicated by fisheries managers employed by the 50 state recreational fisheries management agencies. An analysis of the most important objectives, maximizing sustained yield (pounds) and catch (numbers), and the most important angling factors, revealed that a disparity exists between angler desires and managers' objectives. Some recommendations for eliminating this difference are given.

Moeller, G. H. and J. H. Engelken. 1972. What fishermen look for in a fishing experience. *Journal of Wildlife Management* 36(4) : 1253-1257.

Personal interviews were conducted with 100 fishermen to determine the relative importance of eight selected factors that influence the success of a typical 1-day fishing trip. Elements of the natural environment – water quality, natural beauty, and privacy while fishing – were consistently rated as the most important factors influencing fishing enjoyment. Size and number of fish caught, weather conditions, and ease of access to fishing waters were rated of moderate importance. Facilities available were rated as of low importance. Few differences were found between factor rankings for stream and for lake fishing experiences. Shifts in the importance of factors across different groups of fishermen were also investigated. Results of the study indicate that the concept of fishery management should be broadened to incorporate environmental management, if quality fishing experiences are to be provided.

Paukert, C. P., D. W. Willis and D. W. Gabelhouse, Jr. 2002. Effect and acceptance of bluegill length limits in Nebraska natural lakes. *North American Journal of Fisheries Management* 22 : 1306-1313.

Bluegill (*Lepomis macrochirus*) populations in 18 Nebraska Sandhill lakes were evaluated to determine if a 200 mm minimum length limit would increase population size structure. Bluegills were trap-netted in May and June 1998 and 1999, and a creel survey was conducted during winter 1998-2001 on one or two lakes where bluegills had been tagged to determine angler exploitation. Thirty-three percent of anglers on one creel lake were trophy anglers (i.e., fishing for large ≥ 250 mm] bluegills), whereas 67% were there to harvest fish to eat. Exploitation was always less than 10% and the total annual mortality averaged 40% across all 18 lakes. The time to reach 200 mm ranged from 4.3 to 8.3 years. The relative stock density of preferred-length fish increased an average of 2.2 units in all 18 lakes with a 10% exploitation rate. However, yield declined 39% and the number harvested declined 62%. Bluegills would need to reach 200 mm in 4.2 years to ensure no reduction in yield at 10% exploitation. Both yield and size structure were higher with a 200 mm minimum length limit (relative to having no length limit) only in populations with the lowest natural mortality and at exploitation of 30% or more. Although 100% (N = 39) of anglers surveyed said they would favor a 200 mm minimum length limit to improve bluegill size structure, anglers would have to sacrifice harvest to achieve this goal. While a 200 mm minimum length limit did minimally increase size structure at current levels of exploitation across all 18

bluegill populations, the populations with the lowest natural mortality and fastest growth provided the highest increase in size structure with the lowest reduction in yield and number harvested.

Peyton, R. B. 1987. Mechanisms affecting public acceptance of resource management policies and strategies. Canadian Journal of Fisheries and Aquatic Science 44: 306-312.

Managing the issues which arise from Great Lakes rehabilitation efforts will involve some expertise in psychology and sociology and in the administration of public involvement processes. The components of issues which must be managed include inadequacies in our science, incomplete and/or conflicting public beliefs, and conflicting public values. Decisions must often be made without the benefit of complete scientific information, and the public is poorly prepared to deal with this limitation. Even when scientific knowledge is adequate, segments of the public may be uninformed and create issues. Most issues result from conflicts between users with differing value priorities in management decision. Public involvement strategies exist to increase representative and interactive participation by citizens needed to resolve or avoid many issues, but additional strategies must be developed to deal with the difficult dynamics of value conflicts. The response of management agencies should be to implement long-range programs to develop their own expertise in the dynamics of public perceptions, citizen skills to participate in the management process, and more effective strategies for involving citizens in the difficult, value-laden resource management process.

Radomski, P. J., G. C. Grant, P. C. Jacobson and M. F. Cook. 2001. Visions for recreational fishing regulations. Fisheries 26(5) : 7-18.

We review sportfishing regulations in Minnesota and across North America and discuss potential visions for the future of sportfishing regulations. Creel limits are ubiquitous across North America and they have been generally set arbitrarily with little biological justification. Anglers may not accept reductions in creel limits that actually decrease total harvest. Length-based regulations are now common and most North American sport fish management agencies had numerous water-specific, length-based regulations. The future of fishing regulations could continue to get more complex but there are substantial shortcomings to this future. We present four visions of the future of freshwater recreational fishing, and we pose the question "Does the fact we are managing a pleasure sport mean that we need to rethink our fisheries management philosophy?" Future management of sport fish may rely less on biology and more on social science as we learn to optimize angler satisfaction. Although biology should be the basis for future management, other aspects of the fishing experience besides the number and size of fish caught could be managed. We will need to manage "how people fish" and understand "why people fish" to improve the angling experience. Since many of us chose this profession for nobler reasons than pleasure or sport management, we have difficulties addressing the social issues of fishing quality.

Reed, J. R. and B. G. Parsons. 1999. Angler opinions of bluegill management and related hypothetical effects on bluegill fisheries in four Minnesota lakes. North American Journal of Fisheries Management 19 : 515-519.

We surveyed anglers on four Minnesota lakes who fish for bluegill (*Lepomis macrochirus*) to determine (1) if they would support regulation changes designed to increase bluegill size structure, (2) if their behavior would allow increases in bluegill size



structure to be sustainable, and (3) what they viewed as the causes and remedies for declining bluegill fisheries. The majority of anglers surveyed would not support regulation changes on bluegill fisheries. However, most said they would increase the number of fishing trips they took if increased bluegill size structure could be re-established. We estimated that a modest increase of two trips annually would result in a 16–34% increase in the rate of exploitation on the four lakes. On certain lakes this could jeopardize the sustainability of a quality fishery. The majority of anglers believed that stunting was the cause of the decline in bluegill populations and that removal by managers and anglers was the most important management tool available.

Riechers, R. K., G. R. Wilde, R. B. Ditton and K. M. Hunt. 1991. Freshwater and saltwater anglers: A comparative analysis of differences in attitudes toward management tools. *Proceedings of the Annual Conference Southeast Association of Fish and Wildlife Agencies* 45: 246-253.

Philosophies of fisheries management have evolved through time and have affected, and been affected by, traditional uses of various (different) fisheries. Because of historic differences in management and utilization of freshwater and saltwater fisheries, we expected to find difference among freshwater and saltwater anglers in their support for (attitudes toward) management regulations. Using results from a statewide questionnaire of anglers in Texas, basic social and demographic characteristics and attitudes toward management tools were compared for 3 groups of anglers: those who fish in fresh water only; those who fish in salt water only; and those who fish in both fresh and salt water. Significant group differences occurred for age, income, boat ownership, tournament participation, and years of previous experience. Angler attitudes toward management tools showed significant differences for 5 of the 7 regulatory measures that were compared. Familiarity with regulatory tools appears to be strongly associated with the support that anglers give to any specific regulatory measure. Through understanding angler attitudes towards regulations, managers can better predict behavior towards regulations and adopt strategies that encourage adoption and diffusion of management tools.

Spencer, P. D. 1993. Factors influencing satisfaction of anglers on Lake Miltna, Minnesota. *North American Journal of Fisheries Management* 13 : 201-209.

Principal components analysis of motivations of anglers fishing in Lake Miltna, Minnesota, described four distinct components: outdoor, interactive, angling, and social motivations. Outdoor motivations were positively related to fishing and trip satisfaction, while angling motivations were negatively related to trip satisfaction. Fishing success, targeted species, and local residence also affected angler satisfaction; successful largemouth bass (*Micropterus salmoides*), walleye (*Stizostedion vitreum*), and sunfish (*Lepomis* spp.) anglers all showed higher ($P < 0.05$) satisfactions than unsuccessful anglers, and sunfish anglers showed higher fishing satisfaction than walleye anglers. Anglers residing at resorts showed higher fishing satisfaction and higher satisfaction with number of fish caught than local anglers. The influence of motivations, success, and other variables such as local residence on angler satisfaction supports the theory that angling satisfaction varies among anglers with different characteristics. If satisfying anglers is to be a management goal, managers must consider which policies will be most effective for specific groups of anglers.



Wilen, J. E. 1979. Fisherman behaviour and the design of efficient fisheries regulation programs. Journal of the Fisheries Research Board of Canada 36 : 855-858.

This paper examines the importance of hypotheses about fisherman behaviour for predicting, understanding, and designing efficient fisheries regulation programs. Particular attention is paid to flexible technology fisheries where individuals are free to alter several dimensions of effort. It is suggested that the appropriate hypothesis of share-focused behaviour ensures that there will always be an incentive to combine inputs inefficiently although technical conditions may limit or block the actual ability to do so. Some observations on the success of existing programs are also offered.

Wydoski, R. S. 1976. Angler responses to special regulations. Proceedings of the Annual Conference Western Association of State Game and Fish Commissioners 56: 154-167.

Fishery management is the purposeful surveillance, regulation, and manipulation of (1) the fish habitat, (2) the fish populations, (3) their food supply, and (4) the fisheries. Regulation of angling is a management tool widely used by conservation agencies. The purpose of this paper is to compare regulations with associated aspects of fishery management, to synthesize available information on angler responses to special regulations, and to describe the effects of special regulations on selected fisheries. Acceptance of special regulations by anglers varied by the type of regulation.

Ideally, angling regulations should be (1) few in number, (2) based on active and continuous research to determine their need, (3) made by the State conservation Commission and not by the Legislature, and (4) enforced by well-trained conservation officers who place the major emphasis on prevention rather than detection of the violation.

APPENDIX 1. A summary of regulations for panfish in Canadian provinces and U.S. states. Information was derived from the 2002 summary of fishing regulations from each jurisdiction.

Jurisdiction	Panfish Present?	Open Season	Catch(Possession) Limits		Size Limits	
			Standard	Exception(s)	Standard	Exception(s)
<u>Canada</u>						
Alberta	Yes	None	None	None	None	None
British Columbia	Yes	None	None	None	None	None
Manitoba	Yes ³	All year May 11- Mar. 31; May 18-Apr. 30	6(6)	None	None	None
New Brunswick	Yes ⁴	None	None	None	None	None
Newfoundland & Labrador	No	-	-	-	-	-
Northwest Territories	No	-	-	-	-	-
Nova Scotia	No	-	-	-	-	-
Nunavut	No	-	-	-	-	-
Ontario	Yes	All year closed (some waters)	No Limit	None	None	None
Prince Edward Island	No	-	-	-	-	-
Quebec	Yes	All year numerous open seasons	No Limit	0	None	None
Saskatchewan	Yes ³	May 4-Mar. 31; May 18-Mar. 31; May 25-Apr. 15	6(6)	None	None	None
Yukon	No	-	-	-	-	-
<u>United States</u>						
Alabama	Yes	All year	50(50)	None	None	None
Alaska	No	-	-	-	-	-
Arizona	Yes ⁴	All year	No Limit	10(10) ¹	None	None

Size Limits

Catch/Possession Limits

Jurisdiction	Panfish Present?	Open Season	Standard	Exception(s)	Standard	Exception(s)
Arkansas	Yes	All year	10(20) ¹ ; 50(100) ¹	25(50) ⁴ ; 0	None	None
California	Yes	All year	No limit	0; 25 ¹ ; 5(10)	None	None
Colorado	Yes	All year May 16-Mar. 14; May 1-Dec. 31; Jan. 1-Oct. 14	20(20) ¹	No limit	None	None
Connecticut	Yes	All year numerous open seasons	No limit	None	None	None
Delaware	Yes	All year	50 (no more than 25 per species)	None	None	None
Florida	Yes	All year weekends of 1 st Sat. in Jul.-Labor Day	25(50) ¹	50(50) ¹ ; 20 ¹ 10 ^{2,5} ; 5 ^{1,2}	None	25 cm. min. ^{2,5} ; 30 cm. min. ² ; 20 cm. min. ^{2,5}
Georgia	Yes	All year Nov. 1-Apr. 30	50(50) ¹	30(40) ¹	None	None
Hawaii	Yes ²	All Year	No Limit	None	None	None
Idaho	Yes ²	All year (lakes/ponds) May 25-Nov. 30 (streams)	No Limit	None	None	51 cm. min.
Illinois	Yes ^{2,5}	All year	No limit	25(25); 10(10) 15(15); 5(5) catch and release only	None	20 cm. min.
Indiana	Yes	All year	No Limit ² 25(50) ^{3,5}	None	None	None
Iowa	Yes ^{2,4}	All year	30(30)	None	None	None
Kansas	Yes	All year	No Limit	10(30) ²	None	20 cm. min. ²
Kentucky	Yes	All year	No limit 15(30) ³	None; 15(30) 30 ¹ ; 15(15)	None	None
Louisiana	Yes	All year	No Limit	None	None	None
Maine	Yes	Apr. 1-Sept. 30; Apr. 1-Nov. 30	No Limit	None	None	None
Maryland	Yes	All year	15(30) ¹	None	None	None

Size Limits

Catch/Possession Limits

Jurisdiction	Panfish Present?	Open Season	Standard	Exception(s)	Standard	Exception(s)
Massachusetts	Yes	All year	No Limit	10(10) ⁶	None	None
Michigan	Yes	All year	25(25) ¹	5(5) ¹ ; 10(10) ¹	None	None
Minnesota	Yes	All year Nov. 1-Apr. 30 ²	30(30) ¹	5(5) ⁴ ; 10(10) ^{2,4} 25(25) ¹ ; 20(20) ³	None	18 cm. min. ²
Mississippi	Yes	All year	100(200) ¹	25(50) ²	None	None
Missouri	Yes	All year Mar. 15-Apr. 30	50(100) ^{2,4} 15(30) ³	20(40) ^{2,4} 100(100) ¹	None	20 cm. min. ³
Montana	Yes	All year 3 rd Sat. in May-Nov. 30	No Limit	None	None	None
Nebraska	Yes	All year All year (daylight hours)	30(60) ¹	10 ¹ ; 0 3(10) ¹	None	20 cm. min.
Nevada	Yes	All year 2 nd Sat. in Feb.-Sept. 30	15(15)	None	None	None
New Hampshire	Yes	All year Jan. 1-Oct. 15 (rivers and streams)	None	None	None	None
New Jersey	Yes	All year	25(25) ¹ 10(10) ¹	None	None 18 cm. min. ⁴	None
New Mexico	Yes	All year	20(40)	None	None	None
New York	Yes	All year	50(50) ¹	No Limit; 15(15) ¹ 25(25) ²	None	None
North Carolina	Yes	All year 4 closures based on gear and county	No Limit	30(30) ^{1,7}	None	None
North Dakota	Yes	All year numerous open seasons	35(175) ² No Limit ³	None	None	None
Ohio	Yes	All year Mar. 1-May 1 (daylight hours)	No Limit	None	None	None
Oklahoma	Yes	All year	None	None	None	None
Oregon	Yes	All year (lakes); streams open during trout, salmon, steelhead seasons; closed all year (some waters)	No Limit	None	None	None



Jurisdiction	Panfish Present?	Open Season	Catch(Possession) Limits		Size Limits	
			Standard	Exception(s)	Standard	Exception(s)
Pennsylvania	Yes	All year	50(50) ¹	No Limit 20(20) ¹	None	18 cm. min.
Rhode Island	Yes	All year	No Limit	None	None	None
South Dakota	Yes	All year	25(50) ³ ; 20(20) ³ 25(50) ¹ ; 30(30) ¹	10 ¹	None	None
Tennessee	Yes	All year	20(40) ³ No Limit	10(20) ² ; 30(30) ⁴ 20(20) ^{2,3}	None	None
Texas	Yes	All year	No Limit	None	None	None
Utah	Yes	All year	50(50) ¹	10(10) ^{1,2}	None	None
Vermont	Yes	closed all year (some waters) 2 nd Sat in Apr.-last Sun. in Oct.	No Limit	None	None	None
Virginia	Yes	All year	50(50) ¹ 25(25) ³	No Limit	20 cm. min. ³	None
Washington	Yes	All year (lakes, ponds and reservoirs) Jun. 1-Oct. 31 (other rivers and streams); numerous exceptions	No Limit	0 25(50) ²	None	None
West Virginia	Yes	All year	No Limit	None	None	None
Wisconsin	Yes	All year May 4-Mar. 1	25(50) ¹	10 ¹ 15 ¹ 25(10 can be bluegill)	None	20 cm. min.
Wyoming	Yes	All year closed (many waters)	50(50) ¹	None	None	None

Legend

¹ Aggregate limit

² Bluegill limit

³ Rock bass limit

⁴ Sunfish limit

⁵ Pumpkinseed limit

⁷ No more than 12 of which maybe redbreast sunfish

